SELF-FUELING AIR CARS
compiled by Scott Robertson

*Of the 39 inventors listed below, those that I believe to show the most promise and offer the best information are Chapters 1, 6, 7, 13, 28, and 30.

Interviews with Bill Truitt

After more than six years of collecting information on compressed air and air cars, I sat down with my files to start putting a book together. In going through the vast array of tidbits in my collection, I ran into some flyers that a friend had sent me, which described the work of Willard "Bill" Truitt of McKees Rocks, Pennsylvania. Bill Truitt is a retired designer and builder of race cars. He also invented a flame-thrower and a wind-indicator for artillery during World War II, and had a career in radio broadcasting.

I'd first heard of Bill Truitt's Pneumatic Electric Air Car when I read a book on alternative cars, Auto Engines of Tomorrow by Harris Edward Dark, a technical writer. Dark included a paragraph on Truitt's air car towards the end of his book, but said nothing about how far the car could go between fillups. I always assumed that, since the car used electric pumps to make its fuel or part of its fuel, it would only be able to go a few miles before running out of air. This is what an engineer would probably tell you on first thought. Once I'd gotten Truitt's phone number from information but never called him. I saw no reason to research designs based on hope that perpetual motion might be found in compressed air. For years I'd been looking for practical ways to increase the efficiency of compressed air used in motors, and ignored any theory or claim that seemed to contradict the accepted laws of physics.

Auto Engines of Tomorrow

Harris Edward Dark
1975

The Pennsylvania air car gets its "charge" from an electrically-driven air pump that builds up a tankful of compressed air, which is used to propel the vehicle by means of air motors. Designed and owned by W. "Bill" Truitt of McKees Rocks, who formerly built racing cars in West Virginia and Ohio, the present-day air car is a development of Truitt designs that go back to the 1920s. The car Truitt was displaying in 1974, the "Pneumatic Electric Air Car," had been road-tested on the streets of McKees Rocks for more than eight months. The car is of compact size and has a heavy-duty plastic body with three interchangeable roofs that can convert the car from a sports model to a station wagon to a conventional sedan configuration. Truitt claims a maximum speed of 50 mph with the powerplant, a two cylinder V-type engine powered by compressed air from three tanks, one of one thousand pounds per square inch and two of two thousand pounds per square inch maximum pressure. The car has instant-start capabilities, and the engine runs almost silently, with its only noise, an exhaust hiss, dampened by a special muffler.

So on March 30, 1986, when I decided to go ahead and call Bill Truitt, in case I had anything to learn from him, I almost forgot to have a pencil along for taking notes. When Bill started talking about his sixty-six years of off-and-on experimentation with air cars, I was surprised to find myself writing as fast as I could, trying to get every concept down, and wondering why I even cared about recording what I thought had to be exaggerations. But as Bill continued unbidden to reel off what sounded like a description of a real machine, I felt more and more strongly that I wasn't talking to a con man. There was no pushy come-on, nothing for sale, no offers, no intimidation, and no double talk. He openly admitted that his air car did what engineers thought to be impossible, and I felt he was trying to inform me if I wanted to learn, but he wasn't trying to convince me of anything.

The only time I thought Bill's answers were vague was when I asked about the laws of physics. His explanation of "how he got around the Law" was that his system comprised three separate units--engine, compressor and electrical charging system--whose separateness somehow made possible the anomaly of a car making its own fuel. This makes sense now in light of what I've learned from Bob Neal's patent, in which a pre-charged tank of air (an external source of energy) is used over and over with 100% efficiency to compress more air by mixing with it. Another explanation Truitt offered was that "it isn't horsepower", though he didn't know what else to call It. He responded positively to my suggestion that maybe It was torque, since air cars--like steam cars--trans-

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A NEW DIRECTION FOR INVENTORS by Terry Miller

I'm convinced that I am the first person to actually document how far a wheeled vehicle could go on a certain amount of air. This was done before I documented the actual cost of compressing air. Till now the main draw back to air powered cars has been no range. The simple fact that an air powered car could not carry enough air reserves to travel more than a few blocks or very few miles has led inventors off in the wrong direction. This wrong direction has been toward a way to replenish or re-fill the cars air tanks by some means carried within the car. Patents have been granted for some of the most complex machines imaginable. Most of these inventions were new art, new idea type inventions but, an invention has to work and be practical if it is to find a place in the market place. The fact that most all patents on air powered cars include a new or novel way to replinish the air supply tanks while driving is enough proof of the fact that inventors acknowledged that they could not go any distance unless air supplies were replenished by an on board means on a continuous basis.

My method of using the air several times in stages before exhausting is simple, but, new! Using air more than once gives more usable power per cubic foot of air and gives more speed and range than possible with any other method of air use to date.

Another reason inventors have gone the wrong direction is because gasoline has been cheap. For this reason they knew an air powered car would have to operate for free so to speak. How do you beat cheap gasoline. Easy they thought. Just use air to power the car and re-pump the air as you go. I am the first to admitt that air powered cars have been considered foolish. But inventors have concentrated on replinishment instead of effeciency. From my study it is apparent that no real serious attempt at effeciency was considered because, to compete with gasoline a machine bordering on a perpetual motion machine would be necessary. Inventors were after something for nothing because with cheap gasoline there was no other direction to go. I am amazied at the number of patents granted for self-replenishing air powered cars. Some air replenishment patents are pretty far out, but, others look as though they hold out a promise of partial air replinishment although I personally doubt this. It requires energy to compress air and trying to use the cars motive power to compress air is self defeating.

I would ask future inventors of air powered cars to turn away from the concept of an onboard method of air replenishment and concentrate on possible improvements in my pneumatic engine or a new invention directed at even better effeciency. If one is driven to explore air replenishment a check of all the old patents could save a lot of waisted time and possibly guide one to a new concept as yet not thought of. I get several letters a week saying, "I have an idea". "If you could put a compressor in the car and drive it with the axle or a electric motor compressor powered by a generator you could make your car self sustaining."

mit torque more effectively than gas cars, and therefore require less from the engine in terms of power. However the highly advantageous torque characteristics of air engines aren't enough to explain self-fueling air cars. Another place Truitt indicated I could look for explanations was in his leakproof valve, without which he said the car couldn't work. I have therefore evaluated his mysterious valve as if it worked like Bob Neal's equalizing nozzle, as described later in this chapter. Truitt's statement that his secret valve "works like a heart" tells me that it's probably some kind of two-stage pump that injects pulses of air into a circuit of moving fluid. The other clue I got in response to my repeated requests for lawful explanations was that the key was in how once the wheels are going, you have the whole momentum of the car to tap into. I don't know what to make of this statement.

The components I describe below are the ones Bill used in one or more of the three vehicles he converted to run on compressed air. His first air car, which he built in 1920, was a Stanley Steamer, with an air engine made from a motorcycle engine. He also converted a Buick Skylark and a Rolls-Royce. Though all of these cars were self-fueling, his designs improved over the years till he'd gotten it "pretty well whipped" from 1974-1980.

For an engine, Bill recommends a two or three cylinder refrigeration compressor from a large refrigerator truck. He replaced the steel piston rings with neoprene rings, which lasted 60,000-80,000 miles. The engine could be put in in 35 minutes. The valve could be changed in 30 minutes. The engine ran on 86-125 psi. The car was so fast it was scary to drive; Bill once had it up to 136 mph. It was extremely powerful and accelerated too quickly for someone used to driving gasoline cars, so Bill put a limiter on it so it couldn't go over 55 mph. The engine drove the axle through a turbine clutch, a hydraulic drive invented by a friend of his that slips at speeds up to 300 rpm. Top engine speed was about 1200 rpm. The engine used air non-expansively, that is, the air enters the cylinder throughout the whole piston stroke and exhausts in a still-pressurized state. The engine did not idle. It went right in front of the differential.

The compressor is the heart of the machine. It went under the hood where the gas engine used to be. It was run by a 24 volt DC motor which got its power from two 12 volt car batteries which were charged by two automotive alternators, which were run by pulleys off the engine shaft. The compressor was three-stage, capable of pumping the car's three "acetylene-sized" tanks up to 5000 psi in 14 minutes, but was used to fill them to only 2000 psi. A pressure switch would turn the compressor on when the pressure in the tanks got down to 1000, 1250, or 1500 psi, depending on terrain. In hillier driving, the compressor came on more often, with the pressure switch set to maintain a higher minimum tank pressure. The Mako compressor he used cost him about $1600 at the time. It ran at about half the speed of the engine, and only about a tenth of the time the car was running.

Truitt used several small worm-drive hydraulic air pumps. These pumps were easy to replace, as they slid onto a shaft run by the differential. These pumps put air into the tanks at all times while the car was running. More pumps were required in mountainous terrain, the maximum being 10-12. Because it seems unlikely to me that these pumps could put

out 1000-2000 psi, I believe they were putting out low pressure air which his secret leakproof valve managed to get into the tank, using the movement of air on its way out of the tank as the power source for the entrainment of the low pressure air from the pumps. This is speculation on my part.

When I asked if I could visit him in McKees Rocks, Bill changed the subject and started talking about harrassment he'd gotten from the powers that be, including Exxon. He said the Japanese car companies would send spies to accost his friends and try to get his secrets out of them. The U.S. car companies had his phone tapped. Finally to stop this harrassment he sold the car and the right to make the car to the U.S. Army and NASA, for a .1% royalty for himself or his heirs. The Army has built air powered tanks, jeeps and a helicopter using Truitt's designs.

Bill says the Army generals who are working to develop air powered weaponry have decided that the public isn't ready for cars that have an unlimited range between fillups and cost nothing for fuel. He thinks it would hurt the auto and oil companies too much if air cars were introduced now, and wants to give the U.S. auto makers a chance to catch up with Japan so Japan won't corner the air car market. He speaks of a future where we could have Chrysler air cars, Ford air cars, etc. Bill is satisfied to let the revelation of his secrets happen at the government's pace. The army is supposed to build a model air car for the auto makers to copy. He's told me in writing and over the phone, when I asked for the whole truth, "The rest is Top Secret."

When Bill Truitt was about 17 years old, he built his first self-fueling air car with his father's help. His father was in the car or gasoline business. When the car worked, Bill's dad asked him to keep it quiet, because it might hurt business if word got out. Although there have been times when he was getting sacks full of mail wanting to know about air cars, somehow Bill has managed to keep it quiet for 67 years.

After my first interview with Bill Truitt, I kept thinking about the separateness of the air car components from each other that comprised his first explanation of why the car wasn't breaking the laws of physics. After a few months of seeking and not finding loopholes in the laws of physics, I came to two realizations: 1) the secret had to be in some property of compressed air itself, and in a means for taking advantage of that property; a loophole in the general laws of physics would show itself in the behavior of all cars, and there would be no loophole; 2) the separateness of the components from each other within the system reminds us that a separate or external source of energy or fuel must be available to the car while it's running, without said source of energy or fuel having to be created or generated by the car's motion.

I've only been able to find two possible external sources of energy for self-fueling air cars. One is the heat-pump action of the cold produced by compressed air expanding in an engine. See my book, The Solar Air Car for documentation on this phenomenon. The other external source is the tank full of air that the car must have to start out with. For means whereby a tank full of compressed air might be used to compress more air with 100% efficiency, see the discussion of Bob Neal's patent later in this chapter.

Inventor's Plans for Car That Runs on Air Now Lie Buried Somewhere in U.S. Bureaucracy

An air-driven engine, developed by a 70-year-old inventor, may prove a solution to the "gas crisis" and power the cars of the future.

2/10/74

By CLIFF LINEDECKER
Of the Tattler Staff

"I contacted government people in Washington about it," explained Willard "Bill" Truitt, "but they were too busy trying to get to the moon.

"They didn't know that they'd be running out of gas.

Truitt began work on his "pneumatic air electric car" in 1968 with the help of a friend, now deceased.

The inventor, who now lives in McKees Rocks, Pa., used a remodeled 1958 chassis to house his air-powered engine three years later. He drove the strange contraption 35 miles to a friend's house.

"Eventually, I put 2,000 miles on it," he recalled, "and it never ran out of air.

"I finally had to tear it down to keep thieves from stealing it."

TRUITT, WHO has been a race car driver and mechanic, indicated that he had been inventing and "tinkering" for more than 50 years.

"I never got rich," the inventing wizard recalled.

"But when an idea comes to me, I sit down and work it out."

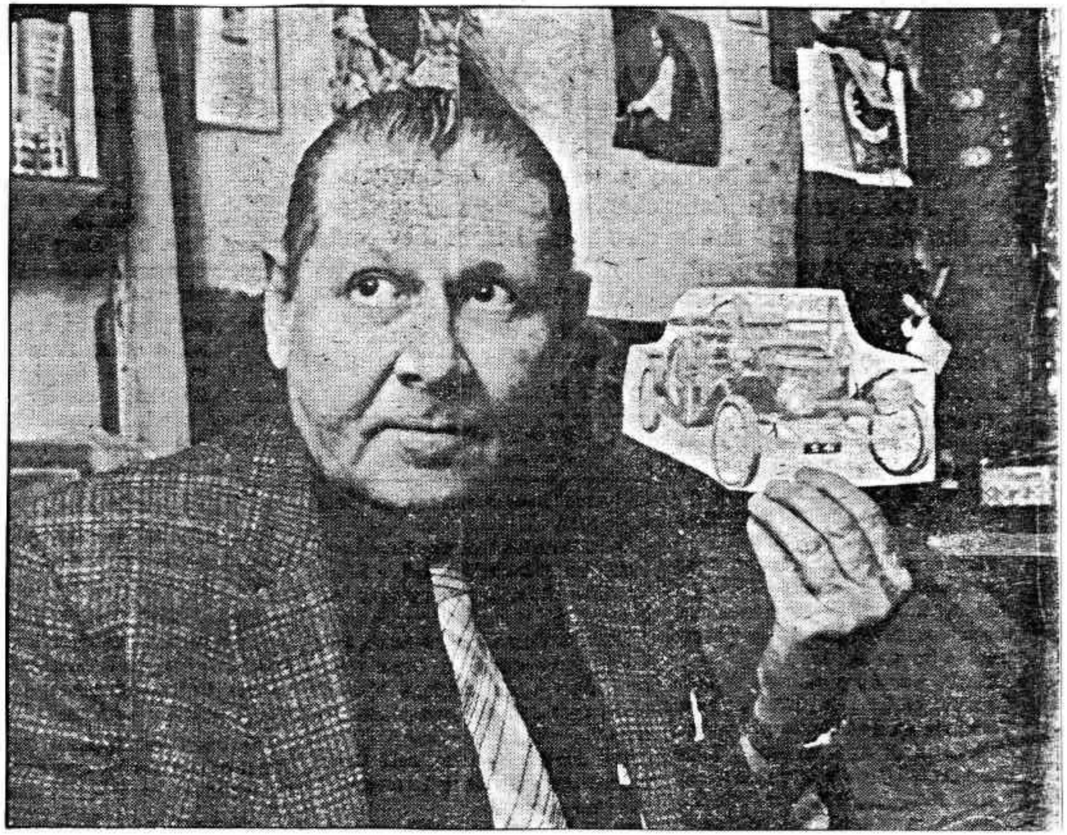
Until recently, Truitt was receiving modest patent royalties from the Army for a flame-throwing pistol and a windage indicator for improved artillery fire direction.

He invented both while serving his tour of duty in 1941.

When earlier patent royalties dwindled to nothing in 1970, and all Truitt had to live on was a meager Social Security check, he began a vigorous campaign to find some financial backing.

California Gov. Ronald Reagan and billionaire industrialist Howard Hughes declined to assist, according to Truitt.

"And I just didn't have the money to do it myself," Truitt told TATTLER.



NOT JUST A PICTURE — Truitt holds a drawing of the real car he had to tear down to keep people from stealing it.

DEVELOPMENT was estimated at more than $150,000 by Truitt.

Finally, with no help in sight, he turned it over to the federal government – free.

"I decided that one of these days I might kick the bucket, and I decided it would take someone else at least 25 years to figure it out," he explained.

"So, I just turned it over to the government."

An aide to Rep. H. John Heinz III, (R-Pa.), acknowledged 'that, through his office, the "pneumatic car" as far back as 1920 when he and will see that he shares whatever is cultivated or gotten from this," Heinz told TATTLER.

The following is a rough description of how the "pneumatic air electric car" apparatus works:

- A battery-operated compressor builds up air in a storage tank with 1,000 pounds per square inch of pressure.
- The compressed air propels a precision direct-drive, rear-mounted, rotary-type engine quite similar to a jackhammer.

car" as far back as 1920 when he tried to convert a Stanley Steamer, but no one was interested.

"But gas was only 15 cents gallon then," Truitt added with grin.

In McKees Rocks

CREATIVE INVENTIVE RESEARCH AND DESIGN
751 BOUQUET ST. HOUSE BOX #7
McKEES ROCKS, PA. 15136

W. "Bill"Truitt, Design. Engr.
Compressed Air Car.
Experimental Div. 771-3839
McKees Rocks, PA 15136

[redacted] INDUSTR

[redacted] INTEREST [redacted] - IT'S HERE.

THE TRUITT COMPRESSED AIR AUTOMOBILE A UNIT RECYCLE SYSTEM
HOW IT WORKS

E COMPRESSOR: This unit is the heart of the automobile is placed under the hood in the chassis of the automobile, will run on Electric,Gasoline or Diesel fuel Gasoline milage is same as your home grass lawnmower on an hr.basis. The Electric is the type we use as we can not make gasoline or diesel fuel The electric compressor motor runs on 24 volt car type batterie (2 used) one for lights and accessories the two together make the 24 volt compresso drive power. Two ALTINATORS CHARGE THE BATTERIES WHEN DOWN TO 1250 P.G. keeping the batteries charged the same as the present automobile,by trip relay system. All automatic,pumping tanks to 2000 psi. in 14 minn.

E COMPRESSED AIR TANKS. The air tanks are similiar to the type used in welding and hospital OXYGEN tanks. fitted in the car chassis in a lined steel cork li ned case. and have been sold in the world for the past years by air reduction firms with years of safety tests made and have a SAFETY FACTOT of 2000 psi. to a rupture pressure of 83000 psi. much higher than any government requirement
All automatic operation.

E ENGINE,(AIR) ston Type.

The tanks are connected to the engine through an accelerator foot pedal operation,same as present car. Dash lock operates main air valve which keep brake on until ready to go. A small hand lever on floor of car operates the forward and reverse drive operation. The engine runs on 80 psi. to 180 psi. as required at top spedd but governor keeps car speed no higher than 55 MIP You will not be stopped by police as car stays within the LAW. The UNIT CYC is all automatic, The COMPRESSOR makes the air for the Tanks,the Tanks are controled by a pressure electric control unit that turns the compressor on when Tanks Got Below 1500 psi. and shut off at 2000 psi.We have (5) Engine designed ahead for the cars of the future.

HEEL COMPRESSOR PUMPS

THIS UNIT IS DESIGNED TO BE AVAILABLE FOR ADDITIONAL PUMPS TO BE ADDED IF CAR IS SOLD IN MOUTAINOUS TERRITORY FOR EXTRY POWER,NOT NEEDED.
The WHEEL PUMPS are designed to run only when automobile is in operation, driving off the differental gear set-up. worm drive to offset.power loss. PUMPS INTRECHANGEABLE for wear and slower compressor on & off operation,(4) (6) (8) or (12) pump units will fit on shaft,complete compressor unit can be changed ~~in~~ in one hour. (4) Bolt assembly. THIS UNIT PUTS COMPRESSED AIR INTO MAIN TANKS WHEN RUNNING ON ROAD OR HIGHWAY AT ANY SPEED.

[redacted]

[redacted] TO BE FURTHER DEVELOPED FOR THE PEOPLE OF THE U.S. TO HELP JOBS & BETTERMENT OF THE COUNTRY TO BE BUILT BY ALL U.S. AUTOMOBILE MANUFACTURERS

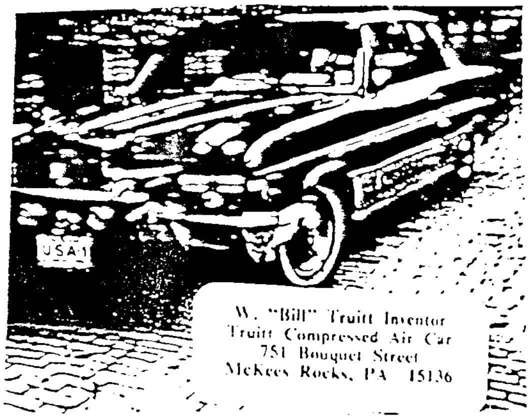
The Safest Automobile In The World,
No Gasoline, No Gas Tank.

PUMPS

In McKees Rocks

CREATIVE INVENTIVE RESEARCH AND DESIGN
751 BOUQUET ST. HOUSE BOX #7
MCKEES ROCKS, PA. 15136

Odor – Non Detect
Hydrocarbons – Less than 60 PPM
Water Vapor – 3 Grams Per Pound of Air
Oil Mist – Less Than 7 Grams Per Cubic Meter of Air
Carbon Monoxide – Less Than .001 of 1%
Carbon Dioxide – Less Than .040 of 1%



W. "Bill" Truitt Inventor
Truitt Compressed Air Car
751 Bouquet Street
McKees Rocks, PA 15136

W. "Bill" Truitt - Inventor
Truitt Air Motors Engineering
751 Bouquet Street
McKees Rocks, PA 15136
Phone 771-3839
The Poor Peoples Car
No Gasoline

W. "Bill" Truitt, Design. Engr.
Compressed Air Car.
Experimental Div. 771-3839
McKees Rocks, PA 15136

DATE:-

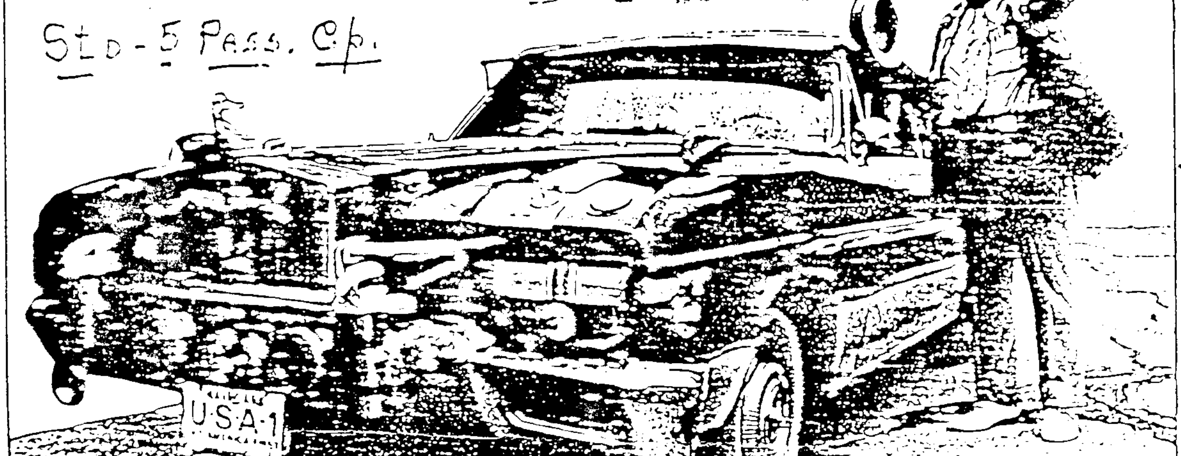
Air Car

Bill Truitt and his air car.

AIR MOTORS ENGINEERING INC.
Pressurized Oxygen Car
W. Bill Truitt, Inventor
McKees Rocks, PA 15136

"SOLVING The GAS PROBLEM"
"No GAS TANK"
"No Pollution"

Std - 5 Pass. Cp.



COMPRESSOR

The [redacted] features-concentric valves, 1000 PSI lubricating oil pressure, needle bearings and ball bearings throughout, ultra-high cooling capacity and efficiency never before made available on a three-stage high-pressure machine.

- 5000 psi - 14 min - 2000 psi USED. -

In McKees Rocks

CREATIVE INVENTIVE RESEARCH AND DESIGN

751 BOUQUET ST. HOUSE BOX #7

McKEES ROCKS, PA. 15136

TRUITT

Air Car

W. Truitt
751 Bouquet St.
Mckees Rks, PA 15136

Truett Protective Devices
751 Bouquet St. Box 7
McKees Rocks, PA 15136

- INVENTOR -

- 1920 - - - 1983 -

Inventor's personal car has bar, telephone compressod air guages, breath-O-later, radio, theft alarm buttons, 10 foot trouble light is located in center top. Has natural air-conditioning. Front has berm light, and top has top blinker light to show when door is open for on-coming driver.

This Pressurized Air Electric Automobile makes its own air while running from differential drive hydraulic air pumps. Makes its own electric for compressor from air driven alternators, keeping battery up at all times

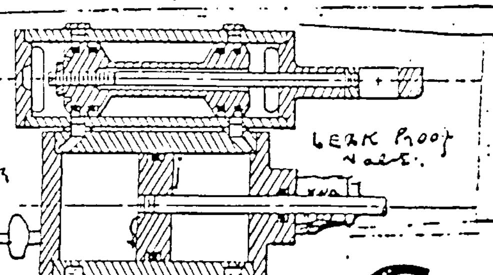
INC
AIR MOTORS ENGINEERING
TRUITT COMPRESSED AIR CAR
BOUQUET
MCKEES ROCKS, PA 15136

W. "Bill" Truitt - Inventor
Truitt Air Motors Engineering
751 Bouquet Street
McKees Rocks, PA 15136
Phone 771-3839
The Poor Peoples Car
No Gasoline

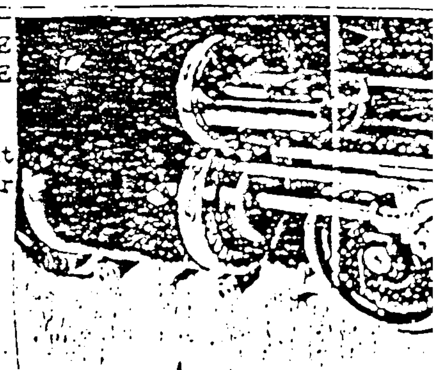
1985

No 3 - TEST CAR -

This* Car has Been assigned to U.S. Army and N.A.S.A for their use and test, Until ready for U.S. Mfg. only - Free. By. W. "Bill" Truitt



THIS TYPE OF STEAM CYLINDE
RUNS A STEAM RAILROAD TYPE
ENGINE WHICH PULLS THE
HEAVY ENGINE AND 16 CARS.
Our Engine is Similiar but
Runs a car 50 mi. per hour
- CONTINOUS -



W. "Bill" Truitt, Design. Engr.
Compressed Air Car.
Experimental Div. 771-3839
McKees Rocks, PA 15136

Cylinders

- a 30 Million Automobile!

MEMORANDUM OF UNDERSTANDING
For use of this form, see AR 27-60; the proponent agency is Office of The Judge Advocate General.

DATE
6-1-82

ADDRESS

HQDA (DAMA-ZE)
Washington, DC 20310

The undersigned, on behalf of (himself, or

Truitt Air Motors-Eng.)
(Company or Corporation)

has made a disclosure of an inventive proposal to the Department of the Army relating to

AIR ENGINE FOR ARMY USE -

It is understood that the Department of the Army has accepted the above proposal for the purpose of evaluating it and advising of any possible Army interest. It is further understood that such acceptance does not imply or create: a promise to pay: an obligation to give up any legal right or to assume any duty; a recognition of novelty, originality or priority; or any relationship, contractual or otherwise, such as would render the Government liable to pay for or to give up any legal right or assume any obligation for disclosure or use of any information in the proposal to which the Government would otherwise lawfully be entitled.

W. "Bill" Truitt

SIGNATURE

W. "Bill" Truitt

PRINT OR TYPE NAME

Inventor - Owner

TITLE OR POSITION

Truitt Air-Motors Eng.

DA Form 4226-R, 1 Mar 74

W. B. Truitt, Design Engr.
Truitt Compressed Air Car 5 Pas.
751 Bouquet St., 412-771-3839
McKees Rocks, PA 15136

I have built 3 of these Cars, Std, Street size, assigned to U.S. Army — Top Secret. — 1985 — Rest is

Scott Robertson
P.O. Box 1574
Grass Valley, CA 95945

3-31-86

No fire, very little noise, 1st continuous operation. Air Engine built 1920.

Dear Mr. Truitt,

We talked on the phone the other day about you air car designs. I want to thank you again for your time. I'm enclosing a self-addressed stamped envelope so you can send me some more technical information .

Bill Truitt Race Car Rider

I think I understand the basic layout , as far as what components are involved. It seems very simple.

What I need to understand better, before I can start trying to design something, is why it never needs to be refuelled. When you say it obeys the laws of thermodynamics, I believe you. You said this is because it uses three systems, the alternators, the compressor and the tanks. I don't understand why it never needs a fillup, but I want to very much, as I've been researching air cars for seven years, and your design is new to me. From my investigation of the air-powered locomotives that were in common use when you were young, I believe that having a compressor on board would be extremely advantageous because of the heat it adds to the air; what I don't understand is how you can run the compressor off the car's momentum without stopping the car. Does the compressor run off the car's momentum during acceleration and cruising, or only during deceleration and downhill driving?

If you have patent numbers, plans for cars you built, specs or model numbers for parts you used, this might be helpful. Your anti-leak valves seem important, and I'm wondering whether you use cutoff valve timing like the old air engines, for full expansion of the air in the engine, or whether this is even needed, since you say you're compressing more air than you can use. Do you know what temperature the air is in the tanks, or going into the motor? Do you know how much air the engine uses per horsepower output? What size is the supply pipe to the engine?

I hope I don't seem pushy, but my curiosity is much more than casual. I have no intention of stealing your idea or trying to get rich off it. I do consider it my duty to preserve as much information as I can about air cars, even though the government already has it, just in case the government loses it somehow. I fully respect all the time and money you've put into your idea, and I will be very careful with anything I learn from you. Please let me know if you want me to send money for photocopies of documents, patent papers, or whatever you'd be willing to share with me.

I'm eager to hear from you.

Have running Model — 1/5 Scale

In Display Case T.U.

NOTE: On June 1, 1986, Bill Truitt returned this letter to me with his replies written in the margin.

Thanks for Letter, Scott Robertson

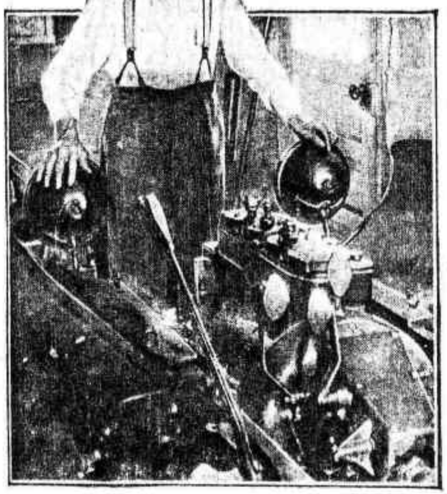
I will Be 83 — Aug 19 — 86 —

Popular Science, December 1925

Compressed-Air Engine Built by Aged Inventor

LOUIS C. KISER, a 77-year-old inventor of Decatur, Ill., has been working for years on a system for driving an automobile by means of compressed air. In adapting his compressed-air system to an ordinary car, Kiser removes the entire gasoline line, the cylinder head, water-cooling system, and self starter. A special cylinder head is substituted and a compressed-air tank added in place of the gasoline tank.

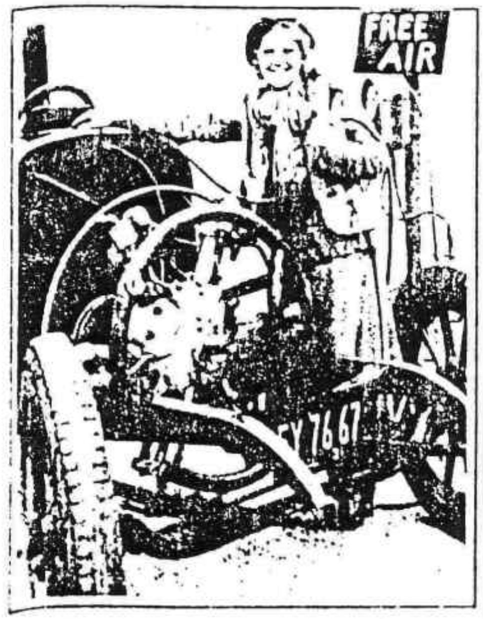
77-year-old inventor of compressed air automobile engine



The inventor claims that the only fuel expense will be the cost of the necessary lubricating oil, but it is not quite clear as to where the compressed air is to come from, since the only way in which compressed air can be obtained is to get power from somewhere to compress it.

AUTO WITH AIR-POWER MOTOR COSTS LITTLE TO RUN

Compressed air has been harnessed to operate an automobile successfully at no cost for fuel. The car has a tank for its air, which is carried to the transmission by a small engine resembling a radial airplane motor. There is no cooling system, no carburetor, no ignition system—nothing except the small air motor controlled by the air throttle. There is no noise except a slight hiss from the exhaust. As the air goes through the engine, most of it is recaptured and recompressed.



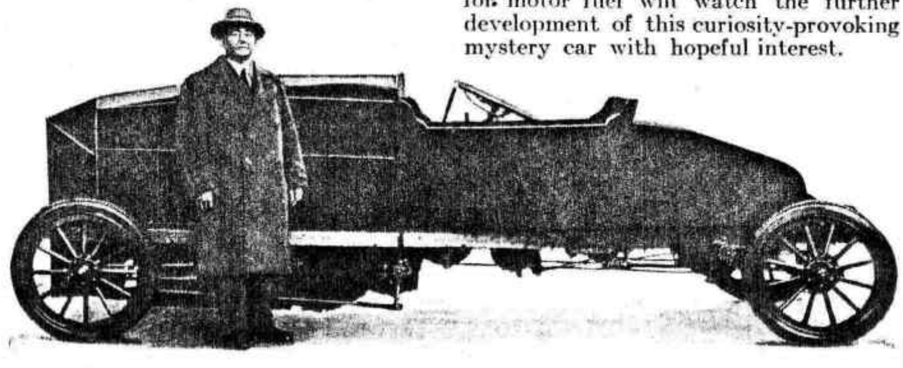
Filling Up the Air Tank of Compressed-Air Auto; Note the Small Radial Engine

Popular Science
July 1926

This Mystery Automobile Runs on Air

THIS inventor has the right idea. Lee Barton Williams, of Pittsburgh, Pa., has invented an automobile which, he claims, runs on air. The motor starts on gasoline, but after it has reached a speed of ten miles an hour the gasoline supply is shut off and the air starts to work.

In its first test, made recently in Pittsburgh, the strange vehicle attained a speed of sixty-two miles an hour. The inventor for the present refuses to explain how air makes the wheels go round. Thousands of automobile owners who are paying out considerable sums every week for motor fuel will watch the further development of this curiosity-provoking mystery car with hopeful interest.



Lee Barton Williams, Pittsburgh inventor, and his automobile that he claims runs on air, after it gets up a speed of ten miles an hour. It recently attained 62 miles an hour

Washington Herald
AN AMERICAN PAPER FOR THE AMERICAN PEOPLE
MONDAY, NOVEMBER 2, 1931.

PATENT ASKED ON NEW MOTOR DRIVEN BY AIR

Inventor Plans to Bring Car Propelled by Novel Engine to Capital Within 10 Days

A model of an air-driven engine which its inventor, James A. Anania, of Newark, N. J., predicts will some day revolutionize the motor industry, was exhibited here yesterday.

In Washington to obtain final patents on his invention, Mr. Anania demonstrated a miniature four-cylinder air engine, equipped with two tanks in which compressed aid is stored for motive power.

Within 10 days, Mr. Anania says, he plans to drive to Washington from Newark in a regular-size automobile in which the motive power will be supplied by his air engine. He hopes to show it to President Hoover at the White House.

Construction costs of an air-driven automobile, Mr. Anania said, are 66 per cent less than present-day automobiles, due to the fact that gearing system is eliminated. Operation costs would also be much cheaper, he added, as no fuel but air is required. The only operating expense would be that for recharging the batteries of the air compressor carried with each engine.

In Mr. Anania's engine, the spent air goes back into the air compressor for use again.

Air-Powered Autos Possible Right Now

By Mark J. Harris

Whether parking meters equipped to recharge electric-powered cars could also be fitted out with compressed air outlets is uncertain. But even if air tanks had to be recharged or exchanged at special stations like industrial oxygen tanks, it would not be difficult to put compressed-air-powered cars on the road right now.

Air power has been used for decades to drive a variety of machinery, ranging from rail locomotives to mining equipment and factory power tools. If you have had dental work your dentist probably prepared the cavities with one of the recently developed air drills that are so fast and powerful as not to require anesthetic in many cases.

There have been isolated efforts to put air-powered automobiles on the road, by tinkerers and enthusiasts who have generally lacked capital for a first-class engineering and production job.

One that was reported to have been quite successful, nevertheless, was the car built back in 1931 by a Los Angeles engineer named Roy J. Meyers. It was driven by an engine of radial (aircraft type) design, with six cylinders. Having an extremely high power-to-weight ratio, like all air motors, the Meyers engine produced over 180 horsepower while weighing only 114 pounds. News accounts of the day—perhaps over-optimistically—reported that the vehicle had a cruising range of several hundred miles if speeds were kept low.

Like steam and electric prime movers, air motors can be perfectly adapted to the unique demands of driving motorcars. Basically, this is because these motors have huge, indeed almost infinite, torque available at low shaft speeds. They need no power-wasting torque conversion (transmissions).

The air motors that would be used in an automobile would resemble a steam engine except that, since the air is not hot, they would avoid the lubricant breakdown that is one of the major technical hangups of steam engines.

In earlier years, air power simply employed a large pressure tank, a control valve and a reversible motor to twirl the wheels. There are still railroad engines from the turn of the century operating every day on this principle, in mines and areas where combustion exhausts are prohibited.

The most advanced—and efficient—air vehicles, however, would probably use liquid air to avoid the dangerous pressure vessel that could explode like a bomb in an accident. A warming device, probably operated from a battery, would heat the liquid air enough to vaporize it and build up the pressure that could drive the engine's pistons.

As with the electric car, there would be no pollution from an air-powered vehicle. A very slight oil vapor would be emitted in the exhausted air, but this could easily be removed by filtration.

It is precisely the bigger cities that have become pollution terminal cases where by far the greatest proportion of vehicle miles are driven in the U.S. each year. Electric and air-powered cars could be put on the road right now that would immediately halt a sizable proportion of this air poisoning.

But whether such cars would be of much use for over-the-road driving is problematical. An electric car could conceivably take a trip across the country, although cruising range in any electric with a battery no larger that the "guts" of an ordinary gasoline car would, today, be quite limited—probably a maximum of 100 miles.

SPOTLIGHT, Dept. 133
300 Independence Ave., S.E.
Washington, D.C. 20003

Secrets of the Fuelless Car
by James J. Branco III
MPG Publications, 1984

R. J. Meyers in 1931 of L.A. and engineer, devised a 6 cylinder radial air engine.. It weighed 114 lbs and produced 180 h.p Reportedly Meyers car could cruise at low speed for several hundred miles. His only fuel was compressed liquid air.

see U.S. Patent #3,925,984 (Holleyman, 12-16-75) & #4,018,050 (Murphy, 4-19-77), which refer to articles on air motors for cars invented by "Meyers and Anania"

from: National Examiner, May 5, 1975,

INVENTED FUEL-LESS ENGINE **Inventor imprisoned!** by RICK VAN ALLEN

When 21-year-old Johannes Wardenier invented the world's first and only fuel-less automobile engine, he should have become one of the richest and most famous men in the world.

Instead, he was mysteriously imprisoned in a mental institution, his design for the engine was stolen and he was kept under constant guard and never allowed to see anyone. Later, he was sent off to a concentration camp where he remained until he was near death and his idea for a motor that ran on air was forgotten.

Some say a major oil company, the second largest in the world, seeing a threat in Wardenier's clever invention, made certain that they would continue to rake in their billions of dollars at the expense of everyone who drives a car by making certain that nothing replaced the expensive gasoline engine.

It happened in Wolvega, a small town about 60 miles from Amsterdam. The year was 1934. A boy named Johannes Wardenier who some say was a genius, was completing work on an automobile engine that ran on air.

When he had at last finished it, the Mayor of the town called a press con ference to announce his young citizen's new principle for a motor that needed no fuel other than one that was in never-ending supply—air.

According to his design, the hot air was pressed into a motor which contained a number of cylinders, half of which go down while the others rise up. As in an ordinary engine, the crankshaft forced a rotating movement. The major difference was that the air after having passed through the cylinders, passed again through the cylinders by means of a compressor at the side, causing a continuous circulation and enough perpetual motion to last three months.

The young inventor had always been a serious student, not given to pranks or hoaxes so when he explained the basic concept to the press and announced that he would have a full-scale working model of the engine the following March, they waited eagerly for the demonstration.

But that day was never to come.

Shortly before the scheduled date, the boy, for reasons never fully explained, was sent away to a mental institution—odd, because he had no previous record of any kind of emotional or mental disturbance. His plans for his miracle engine—and the working model itself—disappeared, never to be found. And while imprisoned at the Gronigan Institution, he was allowed no visitors, not even his parents, nor the mayor of the town who firmly believed that the youthful citizen had come up with an invention that would make the town and its citizens rich.

The boy was later transferred to a concentration camp, although he fit into none of the categories of those who were being sent to the camps. He was not Jewish, not a gypsy, not a political antagonist. And while he was saved from the gas chamber, while there, he fell into ill health.

He confided to fellow prisoners, that he had been imprisoned because he refused to sell his fuel-less engine to the Royal Dutch-Shell oil company in Amsterdam and that, when he refused to sell it to them, they stole his plans and arranged for his "kidnapping" and commitment first to the asylum and, after further being framed, he was shipped off to the concentration camp.

When the oil company was questioned about the matter officials maintained they were unaware of a fuel-less automobile and had never heard of Johannes Wardenier. The company, owned jointly by the Dutch and the British and earning upwards of $1 billion annually, said they had no idea what might have happened to the invention.

In 1960, Wardenier died at 47 years of age, poor, disillusioned, scorned by many who decided he was a faker. Still more know him as a genius who was wronged.

What was he? Genius? Or a madman—full of hot air?

Het mysterie Wardenier en de brandstofloze motor

Datum: 25-04-2002

A.s. vrijdag is op 747 am een radioducemntaire te beluisteren over de Nederlandse uitvinder van de brandstofloze motor Johannes Wardenier.

In de herfst van 1934 baarde een eenvoudige boerenzoon uit Steenwijkerwold opzien door een motor te laten draaien, die -zoals hij het zelf aangaf- een omwenteling zou brengen in de voortbeweging. Hij was de uitvinder van de brandstofloze motor. De 21-jarige Johannes Wardenier is wekenlang voorpaginanieuws geweest. Deze motor zou worden geproduceerd in Wolvega. 'De werkloosheid zal halt houden. Wardenier heeft een uitvinding gedaan, die mensen en machines weer aan arbeid kan helpen', schrijven sommige kranten. De fabriek zou aan 13000 mensen werk bieden. Zo ver is het niet gekomen. Wardenier werd plotseling opgenomen in een psychiatrische inrichting. De behandelende professor verklaarde hem echter normaal en stuurde Wardenier weer naar huis. Op dat moment begint het mysterie dat tot op de dag van vandaag onopgelost is gebleven. Bij thuiskomst hoorde Wardenier dat zijn motor was verdwenen, volgens zijn ouders opgehaald door enkele heren. De motor is nooit teruggevonden. Wardenier vertelde in 1959 over zijn opname: 'In een auto van Philips en met mensen van Philips werd ik naar de kliniek gebracht.' Wardenier leefde na zijn opname in betrekkelijke weelde. Hoefde niet meer te werken, kocht dure pakken, rookte sigaretten en reed auto. In 1960 is Wardenier op 47-jarige leeftijd overleden. Hij werd begraven in Kerkbuurt, bij Steenwijk. Zijn graf is niet te vinden en wordt niet vermeld in de archieven.

Terug naar het nieuwsoverzicht

Opmerkingen, ideeën en reacties kunt u sturen naar info@fsf.nl

(end)

(translation of above article by website: systranbox.com, and edited by me):

The mysterie Wardenier and brandstofloze the engine

Date: April 25,-2002

Next Friday are on 747 am radio-documentary concerning the Dutch inventor of brandstofloze the engine listen to Johannes Wardenier.

In the autumn of 1934 bore a simple boerenzoon from Steenwijkerwold dreads by leaving turns, which an engine - as he indicated it itself - would bring a revolution in transportation. He was the inventor of brandstofloze the engine. The person whose birthday it is Johannes Wardenier voorpaginanieuws lasting several weeks has been. This engine would be produced in Wolvega. Unemployment will come to a halt. Wardenier have done an invention, which can help people and machines to labor, write some newspapers. The factory would offer work to 13,000 people. This way far it has not come. Wardenier was suddenly incarcerated in a psychiatric institution. However, the treating psychiatrist considered him normal and sent Wardenier home. At that moment the mystery starts that up this day has remained unsolved. To thuiskomst Wardenier belonged that its engine had disappeared, according to his parents picked up by some officials. The engine has been never retrieved. Wardenier said in 1959, concerning his prerecording: 'in a car of Philips and with people of Philips I was brought to the clinic.' Wardenier lived after his prerecording in relative opulence. Had no longer work, bought expensive packages, smoked cigarettes and drove car. In 1960, Wardenier on 47 person whose birthday it is age have died. He was buried in Kerkbuurt, at stone district. His sepulchre is not find and is mentioned in files.

To the nieuwsoverzicht

Observations, ideas and responses can send you to info@fsf.nl

Interview with Bob Neal's Son
*Luther Rangely, October 14, 1988

(Floyd Neal started right in describing the engine hardware in some detail. I got my tape recorder hooked up while he was talking, and steered the conversation toward the equalizer, or "special valve" in the tank.)

LR: Did you see the inside of the tank where that one special valve was?
FN: Now he had a special valve where he could load the tank with very little pressure. That was a--the valve looked like an extremely skinny, long plumb bob. That's about all I can remember, like I say, I was just a small boy.
LR: How old do you think you were? Maybe 16 or so?
FN: Oh no, I was younger than that. Oh, probably maybe seven or eight years old, and probably the last I had anything to do with it, 'cause I was out going to school, probably maybe 13 to 15. But I couldn't really give you any good detail.
LR: Do you know about how long or how big the tank was?
FN: Well the storage tank was a streetcar tank. If I remember right they were probably about 16 inches by probably 4 feet.
LR: Pretty big tank, huh?
FN: Yes, the reason he used that, it was available. You probably wouldn't have to have that big a tank. As far as that goes, it was actually just to start it with. 'Cause then you see it starts producing air on its own.
LR: Do you know what the principle is of being able to get the low pressure air into the tank?
FN: That was, <u>he</u> felt, the valve. It was a type of valve that--it was a <u>double</u> valve of some sort.
LR: Double check valve according to the patent.
FN: Yeah, and you could load the tank with a lot less pressure than was in the tank.
LR: Did he ever talk about water hammer or pulsejets?
FN: No...
LR: You know when your water pipes start buzzing, vibrating in the wall, that kind of principle is what makes pulsejets work, and I was thinking possibly it was similar to that.
FN: I couldn't really tell you. Have you come up with anything that you're working on?
LR: Well no, I'm just a researcher, and this is so far the only patent I've found that actually said what it was trying to do. It doesn't say what the working principle is but I think I've figured it out. I think if you make the air vibrate, then it organizes itself into high pressure zones and vacuum zones, and the vacuum waves can be used to let that low pressure air in. So it's kinda like a ram pump, and pulsejets and other wave-type machines that work on causing the fluid to vibrate and make waves. So that's what I think it is, it seems to make sense to me, and that's what my research seems to lead to.
FN: Well it's important to get that research. Have you actually developed any kind of engine?

*A.K.A. Scott Robertson

LR: No, what I've got is, I've built the tank and I put the two check valves inside the tank, sorta like the way it looked in the patent, and I've got an air motor running a rotary compressor, to put the low pressure air in. And I'm getting low pressure air into the tank all right--
FN: About what kind of pressure?
LR: About maybe ten pounds--I can get it in at two pounds but if you run the air motor faster it pumps it up to a higher pressure. It's still going in at a much lower pressure than what's in the tank. So I think it's working, and I think having the compression and engine cylinders on the same crankshaft is the secret. That's why I'm running the compressor direct with the air motor, so they're going at the same speed.
FN: Sure.
LR: Yeah. I think that's your dad's trick is to have the pulsations entering and leaving the tank at the same time so you just have that very clear, distinct wave in it.
FN: Does Mr. M. have a picture of the engine?
LR: Well he says he's got an article but he says it's off in a box somewhere and he doesn't even know where to start looking for it.
FN: I thought he might have a photograph. Of course you're trying to discover something that's altogether different?
LR: Well, yeah, I'm mainly sort of an air car advocate you might say. I'm exploring the whole area and I'm looking at all the different systems I can find, and so far I think this is the best, and I'm concentrating on it. And hopefully I'd like to build an air car that uses this principle--is the patent owned by someone now?
FN: No, you know, it's run out. It's public domain. I was thinking about, oh a few years back, renewing it, but then it wasn't right for me and I just didn't deal with it and now I have no interest in it.
LR: Well it seems to me like it sort of works similar to a perpetual motion machine, which is supposed to be impossible.
FN: You know, when he patented that thing--he had trouble patenting it. Because they notified him and told him that the United States Patent Office was not interested in perpetual motion. And he fired a letter back to them and told them he wasn't either, he just wanted to patent an engine that was functional. And as a matter of fact he got busy and made a little--a small prototype--a hand carried model. And as a matter of fact I went with him to Washington when I was a little boy, and he put it up on Garrett Whiteside's desk--he was top man at the time--started the thing up, and he called in the investigative men, and they had to issue him a patent. You can't argue with a functioning engine, right?
LR: That's right. Well that's great. So the little model had the tank and the valve and the--
FN: Yes, it had everything and he could actually carry it in.
LR: Well that's pretty good because they say in no uncertain terms that they won't grant one, and there's so many air car

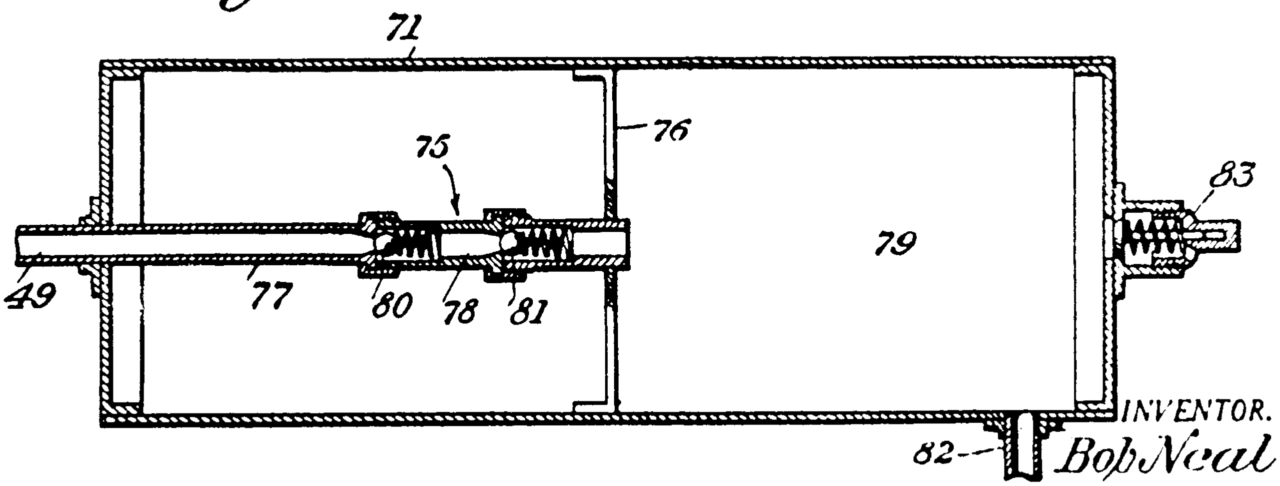
patents that--
FN: Yes. Don't ever mention perpetual motion.
LR: Right. Have you ever heard of anybody else that's done something like this with air?
FN: No, I heard there was someone in the South, a couple years ago, but I don't know if it was just rumors or what. But I didn't really know about it.
LR: What was your dad's relationship with Mr. M.? They were corresponding with each other? Or they were friends?
FN: Well, I don't really know how they got--oh, I know what it--my dad's sister, my aunt, and her husband were living in California somewhere, and I think they were sitting in a city park or something, and the conversation just came up, during the conversation, and my uncle said, well, his brother-in-law was--oh, it was "odd things"--but he said his brother-in-law was working on an engine that ran on air. And Mr. M. heard that, and got interested, and got his address and everything and came down. I remember when he came down. That's how that started. I think that was about '45.
LR: Well I've been working on this research for nine years and someone introduced me to Mr. M. over the phone. We had a three-way phone conversation and he started talking about this and we tracked down the patent. And I thought about it for about a year and a half before I figured out this wave principle for how it might work, and got some research to back it up. I think we're doing pretty good. Would you like to be on my mailing list in case we get something going and put out a newsletter?
FN: Yeah. You know, there was another fellow that was interested in this; that was William Lear. He was kind of interested in seeing an air engine a couple of years ago. He came down to see me a number of times also. And that was over this valve--in the tank.
LR: Did he look at it?
FN: Well, I didn't have it. He came down to <u>my</u> place.
LR: Oh. He's sort of like me, he was trying to get information from you.
FN: Right. And I don't know, he did come up with some sort of an engine--steam, though, I think--and busses in L.A., years ago, and also in police cars. But I don't know.
LR: Was he adapting your father's invention?
FN: Well, at the time, he didn't know if he was gonna go air or steam.
LR: Mr. M. says you had to stop making this or stop developing it because somebody came from some government or something.
FN: That was during the war years?
LR: Uh-huh.
FN: Yes, as a matter of fact, my sister was even kidnapped over it. Germany wanted it real bad. They tried to buy it. And of course my dad didn't do business with foreign powers or the enemy. Then they tried it their way. And they threatened him and said they'd have his family members killed off one at a time. What happened is he dismantled it, and scattered the parts all over the countryside. They just

literally scared the old boy to death.
LR: That was the Germans, huh?
FN: Uh-huh.
LR: That's pretty bad.
FN: Yeah. Poor timing for him.
LR: That was right after he got it patented?
FN: Yes. His first engine was a lot bigger. The first one was fourteen cylinders--air compressors--it was a big "V". Then he decided that was too much, and then his last one was--he called it the "Model 39"--it was just half a block. It looked very similar, and the same size, as an old straight-8 Buick, because the hangers and everything would drop right in on a straight-8 Buick. Because that's what he had at the time, and he wanted that to drop in there, and use the same drive line and everything. The engine actually looked like a letter T.
LR: A letter T?
FN: A letter T. Just straight like an old straight-8 and it was a "V" out front where the two pullers were, set a little off to the side. The crank on that was perfectly round. The pullers had a little larger throw. The engine was basically the same thing cut in two from the original patent. Seven compressors is like fourteen, working both up and down. I remember it, he hooked it up to a machine lathe and had it running that. It worked!
LR: All right. Well I think it'll work because I'm partially showing it myself, a pretty crude, rigged-up system.
FN: Well, have you actually produced an engine?
LR: Well, not an engine, I'm just putting components together, I've used an air motor and I'm running a compressor with it, and I'm having that compressor put the air back into the tank. It's not putting enough back in the tank yet. Does his air motor cylinder--did they use the air pretty efficiently or did they let the air come in through the whole stroke and then exhaust it?
FN: Well, evidently it was efficient but he had no way of using the same air. His engine, I believe it would fill the tank I believe to 140 or 150 pounds and then the excess would escape.
LR: And then the exhaust from the engine just exhausted, right? It wasn't recaptured?
FN: Yeah, just like a regular combustion engine.
LR: Was the safety valve letting air out all the time or only when it was idling?
FN: Well, it maintained that pressure. And if I remember right, I could hear the air leaving all the time, so I think it was producing quite a bit more even under load.
LR: So even when it was running, the safety valve was letting out a kind of a regular spurt?
FN: Yeah. Uh-huh. It made a hissing noise because he didn't muffle it. He just turned it loose.
LR: That could be a key. If the safety valve was letting air discharge all the time, then that's important because it could be causing the pulsejet effect. Sudden discharge like that--

when you suddenly let a burst of air out through your safety valve--can create a vacuum inside the tank.
FN: Sure. That's what it is, it's one of the features. That's what he said, "The valve is the feature." And like I said, as a small boy, I was thinking of other things.
LR: Right. Well, those are pretty much the questions I had for you, I really thank you for taking time with me--
FN: Well, I wish I could help you more, I just can't remember the finer details.
LR: Well, that's fine, I think that the patent's pretty complete, but they just left the working principle out. It's probably just patent lawyers' tactics, you know.
FN: Yeah, sure. That's the legal people for you.
LR: Yeah. All right, Mr. Neal, I appreciate your taking time with me.
FN: Well I appreciate talking to you. Hope it works out.

CONSTRUCTION

Fig. 6.



Bob Neal's U.S. Patent #2,030,759 shows an equalizer (75) that lets the compression cylinders pump low pressure air into a high pressure tank (71) without compressing it to get it in. Possibly the Maxwell's Demon that physicists have been debating for over a hundred years, the Neal Equalizer may decrease the cost of compressing air to nearly zero.

Feb. 11, 1936. B. NEAL 2,030,759

COMPRESSOR UNIT

Filed Jan. 9, 1934 3 Sheets-Sheet 1

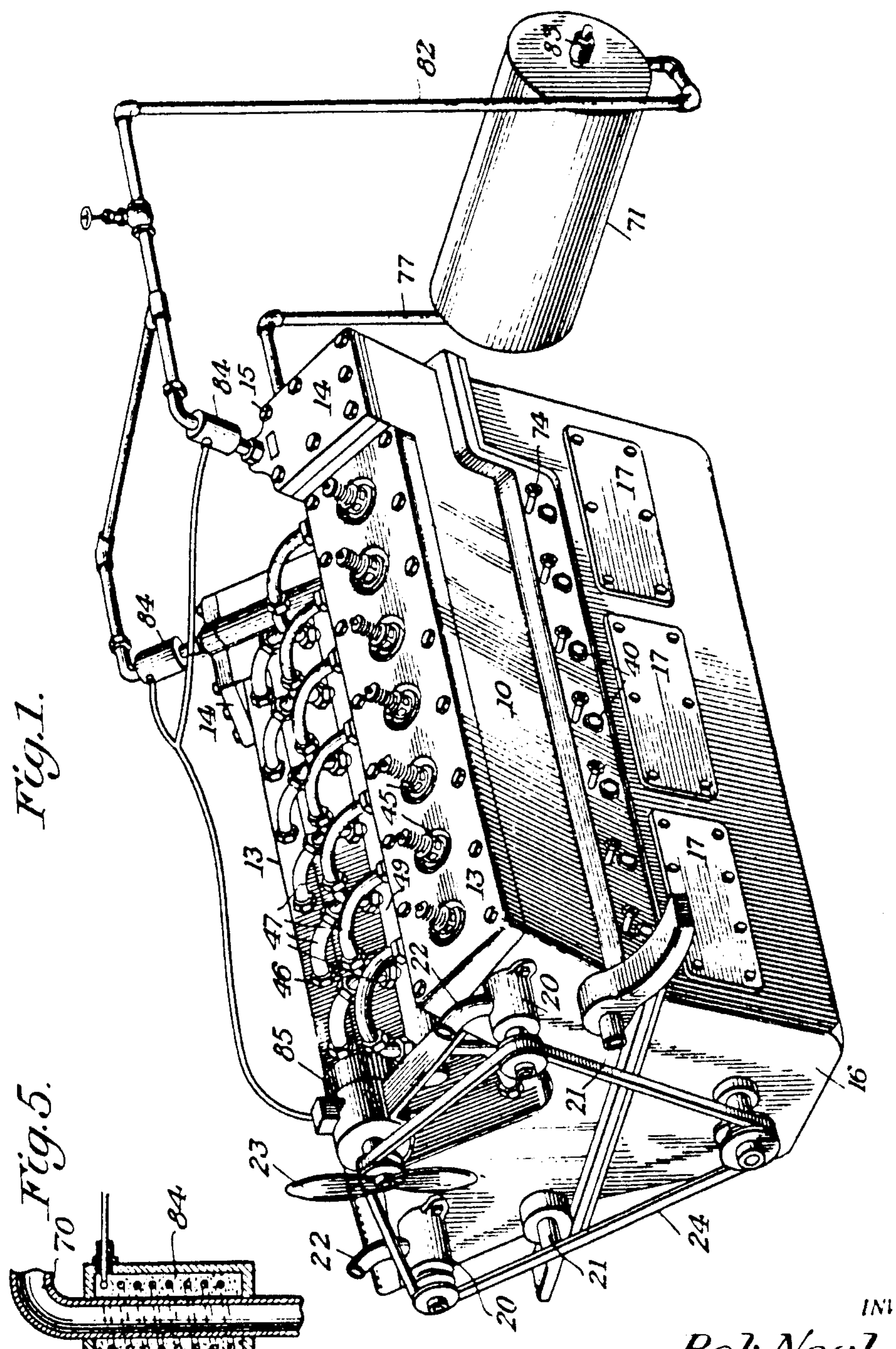


Fig.1.

Fig.5.

INVENTOR.
Bob Neal
BY
[signature]
ATTORNEY.

Feb. 11, 1936. B. NEAL 2,030,759

COMPRESSOR UNIT

Filed Jan. 9, 1934 3 Sheets-Sheet 2

Fig. 2.

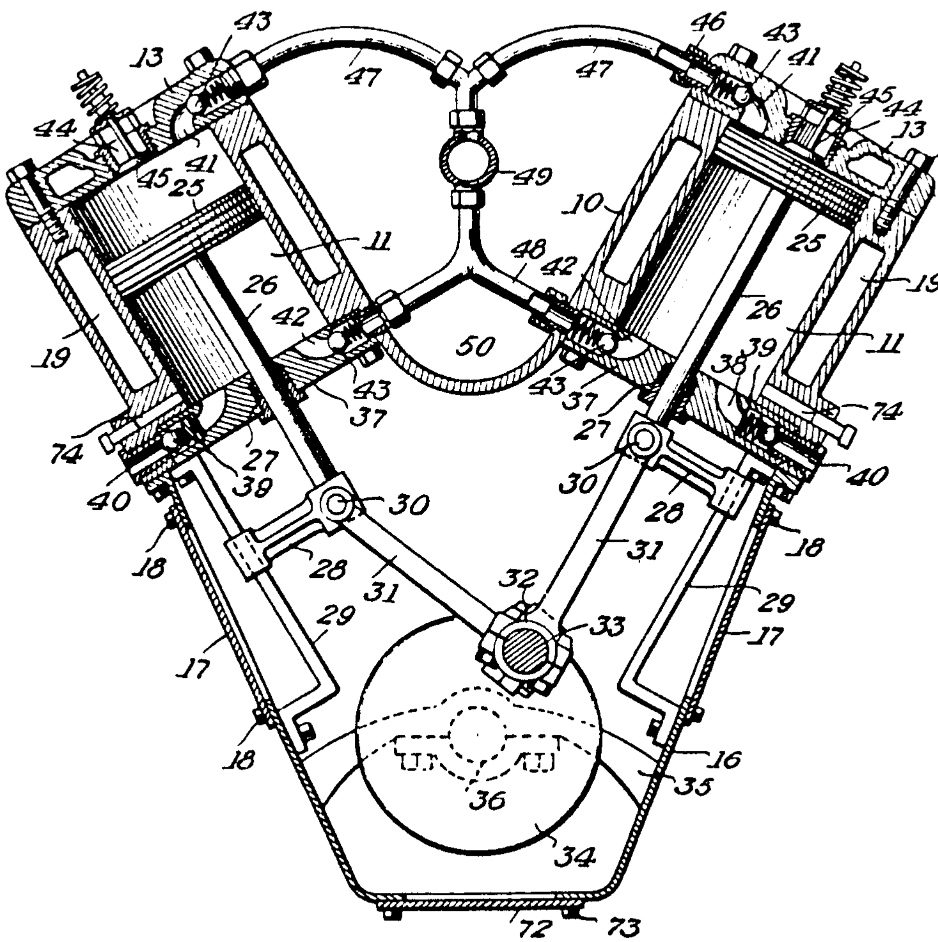
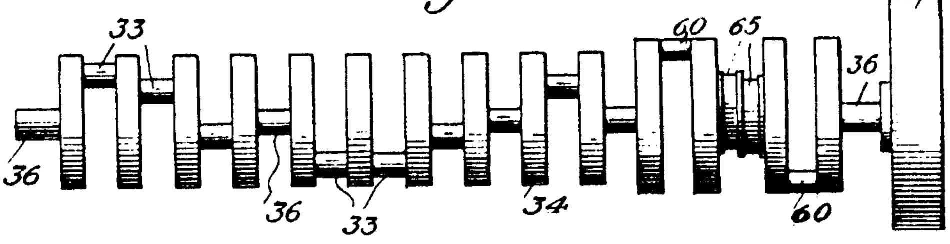


Fig. 4.



INVENTOR.

Bob Neal

BY

ATTORNEY.

Feb. 11, 1936. B. NEAL 2,030,759

COMPRESSOR UNIT

Filed Jan. 9, 1934 3 Sheets-Sheet 3

Fig.3.

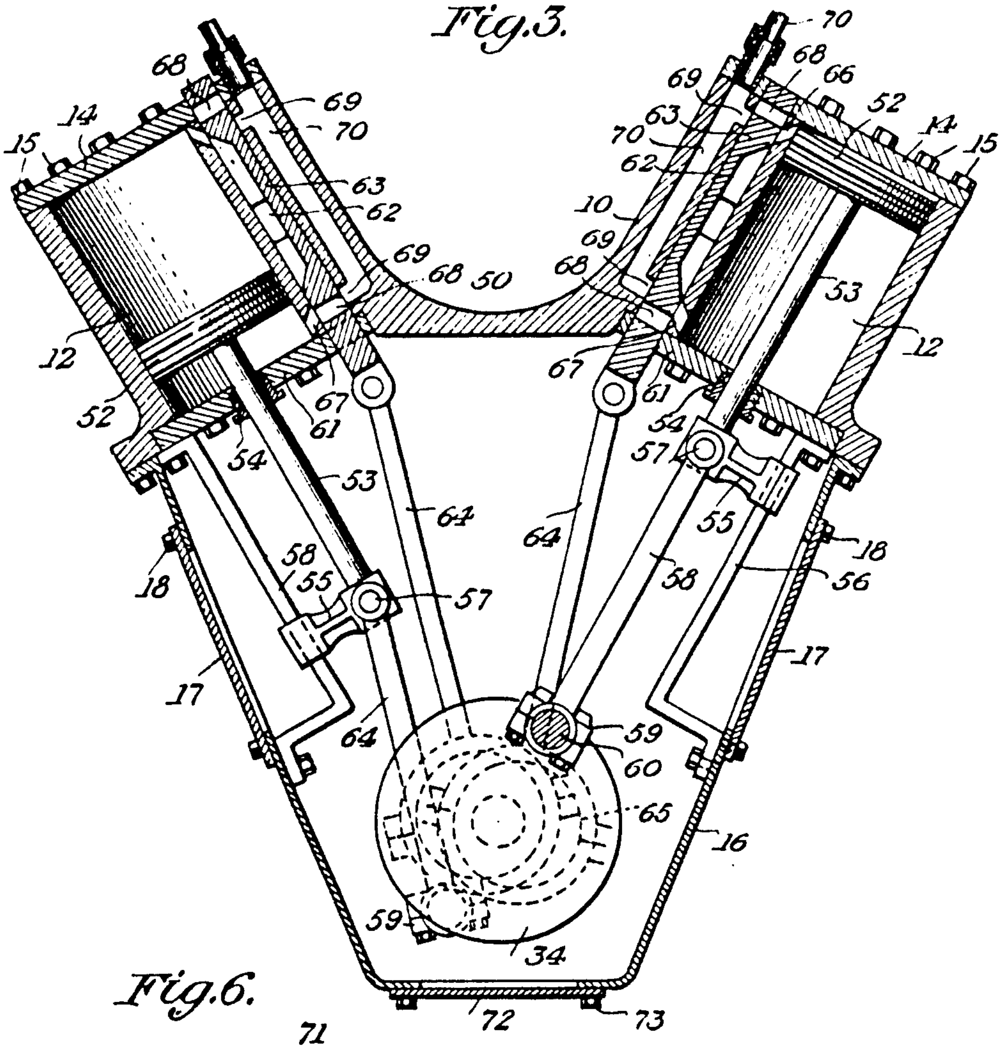
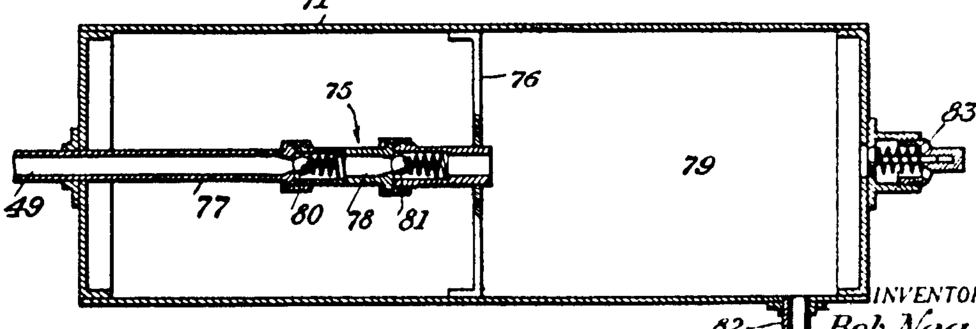


Fig.6.



INVENTOR.
Bob Neal

BY

ATTORNEY.

Patented Feb. 11, 1936

UNITED STATES PATENT OFFICE

2,030,759

COMPRESSOR UNIT

Bob Neal, Arkadelphia, Ark.

Application January 9, 1934, Serial No. 705,964

1 Claim. (Cl. 230—187)

The invention relates to a compressor construction, and more particularly to a combination fluid operated engine and compressor.

The primary object of the invention is the provision of a compressor of this character, wherein there is arranged an automatically counter balanced crank shaft and fluid equalizers within a storage tank, which makes it possible for the said engine to operate on constant reserve tank pressure so as to actuate additional equipment, the pistons for the engine being also automatically balanced and suspended when the said engine is in operation.

Another object of the invention is the provision of an engine of this character, wherein the same is operated from air under pressure, the said air being supplied by compressors, these being in bank with the engine construction.

A further object of the invention is the provision of an engine of this character, wherein the same is of novel construction, as the engine proper and the compressors are operated from the same crank shaft which is of the automatically balanced type, so that high efficiency is attained.

A still further object of the invention is the provision of an engine of this character, which is comparatively simple in construction, thoroughly reliable and efficient in its operation, strong, durable, and inexpensive to manufacture.

With these and other objects in view the invention consists in the features of construction, combination and arrangement of parts as will be hereinafter more fully described, illustrated in the accompanying drawings, which disclose the preferred embodiment of the invention, and pointed out in the claim hereunto appended.

In the accompanying drawings:

Figure 1 is a perspective view of the engine constructed in accordance with the invention.

Figure 2 is a vertical transverse sectional view through the compressor part of the engine.

Figure 3 is a vertical sectional view through the power part of the engine.

Figure 4 is a detail elevation of the crank shaft of the engine.

Figure 5 is an enlarged sectional view through one of the electric heaters for the engine.

Figure 6 is a vertical longitudinal sectional view through the air storage tank including the equalizer.

Similar reference characters indicate corresponding parts throughout the several views in the drawings.

Referring to the drawings in detail the engine in its entirety comprises a cylinder block 10 having formed therein the series of compressor cylinders 11 and the power cylinders 12, respectively, the block 10 being of the V-type and closing the upper ends of said cylinders are the removable heads 13 and 14, respectively, which are secured in place by head bolts 15, as is conventional. Beneath the block 10 is the crank case 16, which at opposite sides carries the detachable plates 17, these being held in place by fasteners 18 and such plates are seated so as to be leak proof. The block 10 is chambered to provide a water jacket 19 about the cylinders, while at the forward end of the said block are water pumps 20 circulating water through the inlet pipe 21 which leads into the jacket and letting said water out therefrom through the outlet pipe 22 leading from said water jacket. Next to the pumps 20 is a fan 23 operated from a belt 24 which also drives the pumps.

Working within the cylinders 11 are the reciprocating pistons 25, their rods 26 being slidable through packing glands 27 and fixed to crossheads 28, which are slidably mounted upon guides 29 secured within the crank case 16 to opposite side walls thereof. These crossheads 28 are fitted with wrist pins 30 pivotally connecting therewith the connecting rods 31 which by the bearings 32 are engaged with their cranks 33 of a counter balanced crank shaft 34, which is mounted in supports 35 arranged in the crank case 16, the shaft being supplied with the required bearings 36.

The inner ends of the cylinders 11 are fitted with inner end heads 37, which are provided with air intake ports 38, these being fitted with spring ball inlet checks 39, the air having admission through passages 40 opening exteriorly of the block 10. The glands 27 are associated with the heads 37.

The heads 13 and 37 are provided with the compressed air outlets 41 and 42, respectively, these being fitted with spring ball checks 43, the heads 13 being also provided with the central air inlets 44, which are fitted with spring checks 45. By couplings 46 are attached to the air outlets 41 and 42 the outlet feed pipes 47 and 48, respectively, these leading to a main conduit 49 located in the center channel 50 in said block 10.

At the rear end of the block 10 and on the shaft 34 is the fly wheel 51, this being of conventional type.

Working within the cylinders 12 are pistons 52, their rods 53 sliding through packing glands 54 and fixed in crossheads 55 slidably mounted upon guides 56 which are secured within the crank

case 15 at opposite side walls thereof. The crossheads 55 carry wrist pins 57 connecting therewith connecting rods 58, these being engaged by bearings 59 with their respective cranks 60 of the crank shaft 34, the inner ends of the cylinders 12 being also closed by inner heads 61 with which are associated the glands 54.

On the cylinders 12 are slide valve chests 62 in which are the slide valves 63, these being operated by throw rods 64 actuated by cams 65 and such valves controlling the air admission and exhaust of air to and from the cylinders 12 through the ports 66 and 67, and these valves 63 are provided with the ports 68 for the delivery of air under pressure from the inlet passages 69 common to a lead 70 from a compressed air storage tank 71.

The bottom of the crank case 16 is fitted with a removable plate 72 which is secured in place by fasteners 73, and when this plate is removed access can be had to the crank shaft 34 and the bearings for the engine, as well as other parts within said crank case, as should be obvious.

Leading into the cylinders 11 are the passages 74 of a lubricating system (not shown).

The storage tank 71 for the compressed air includes therein a double check discharge nozzle 75, this being supported by a member 76 and leading to this equalizer is an air inlet pipe 77 which has the communication 78 with the chamber 79 formed by said tank. In the equalizer 75 are the spaced spring ball checks 80 and 81, respectively, one being for the inlet side and the other for the exhaust or outlet side of said equalizer. This pipe 77 is connected with the main conduit 49, while a pipe 82 is connected with the leads 70, the tank being also fitted with an automatic relief valve 83 of any approved type.

About the pipes 70 for the passages 69 are the electric heating units 84 which are for the purpose of heating the air under pressure above a freezing temperature when delivered from the tank 71 to the cylinders 12.

Supported on the block 10 is an electric generator 85 which is driven from the shaft 34 through a belt 24 and this generator is included in an electric circuit which also has the heaters 84 so that these will operate from current furnished by said generator.

The storage tank 71 with the equalizer is so constructed that it is possible to pump air into the said tank with a tank pressure of two hundred pounds, while the compressors are only pumping against fifteen pounds or atmospheric pressure. Outside air pressure source can be coupled with the tank to augment that pressure derived from the cylinders 11 of the engine.

What is claimed is:

In a structure of the kind described, a V-shaped cylinder block provided with upwardly divergent cylinders, end heads fitted to said cylinders at opposite ends thereof, each head having valved inlets and outlets, a main outlet lead between the cylinders of the block for a storage tank and having lateral branches to the outlets at the inner sides of said heads, one inlet being located at the center of each head at the outer ends of said cylinders while the remaining inlets are at the outer sides of the heads at the inner ends of said cylinders, a substantially V-shaped crank case fitted to the block beneath the cylinders, a counterbalanced crank shaft journaled in the crank case, pistons operating in the cylinders and having rods extended into the crank case, crosshead guides fitted to the sides of said case interiorly thereof, crossheads connecting the rods with the guides and slidable on the same and connecting rods operated by the crank shaft and pivoted to the crossheads for reciprocation of the pistons.

BOB NEAL.

October 31, 1980

Interview with George Heaton
by Scott Robertson

Toward the end of October, my co-worker Maria invited me to Halloween dinner with her family at their home. She said her husband, George, had built some air cars, and suggested I talk to him about his experience. I couldn't believe that someone else had thought of running cars on air. My elation at finding a possible source for usable information made up for my disappointment at not being the first.

At the Halloween dinner, Maria told me that her husband would choose his own time to bring up the topic. Some time later, George told me he'd take me aside after he'd had a little more time to think. When he finally beckoned me to join him in another room, I was paying attention. Though I wondered if this might be a prank or a misunderstanding, he hadn't been talking long before I had my notebook out.

And there was no reason to think that either Maria or her husband was a prankster. I knew from spending long hours with Maria at the shop where we both worked that she was an intelligent, conservative working mother and the wife of a friendly and generous man of many accomplishments. As he began to reminisce, George was telling me that in 1969 he'd been the vice-president of the California Fuel Dealers Association. In that role, he'd testified before a legislative committee concerning the environmental dangers involved in the use of the catalytic converters needed with unleaded gas. He also warned me about compressor explosions, saying that one drop of oil contamination in an oxygen compressor could blow up a whole building. Unlike oxygen, compressed air isn't explosive, but he wanted to impress me with the seriousness of taking safety precautions when working with pressure equipment.

George told me that around 1949, he and a friend converted some motorcycles and cars to run on compressed air. They converted the existing gas engines to run on air, with several modifications that George described.

The cars they built "worked like perpetual motion machines." His wording seemed to imply that the car seldom or never ran out of air, that this is considered impossible by those who should know, that it obviously is not impossible because George has done it, and that it's still considered impossible by those who should know. The key to doing the impossible was to put low pressure air into a high pressure tank, without having to compress the air first, that is, without having to force it in against the resistance of the pressure in the tank. This allowed the use of small air pumps running off the car's motion to keep the tank full, while the engine ran off compressed air leaving the other end of the tank. George didn't remember exactly how to get low pressure air into a high pressure tank, but he thought a good compressor man could probably figure it out. He did recall that the air entered the tank in a stream of quick spurts, or pulses, and he thought it might have entered the tank "at an angle or something."

George and his friend "weren't engineers enough to know what pressures to use," and as a result they had trouble with their engines blowing up. That didn't keep them from driving their air cars across the country several times. The last time George was driving his air car across Nevada, a piston blew out the top of the engine, through the hood, and up into the sky, where it disappeared from sight. Since gasoline was so cheap at that time, the hassles and hazards involved in building experimental cars outweighed the disadvantages of buying gasoline, and they built no more air cars.

George suggested I get around the problem of converting existing engines to run on air, by using a 100 horsepower turbine air motor, which he said would weigh only 25 pounds. My later research turned up the 51A turbine air motor made by the Tech Development Company of Dayton, Ohio, which fits George's description very well.

I left George's home with a head full of ideas, but without the background to put them to use, or even to properly research them. Because I didn't know how to confirm or deny George's claim to have achieved a perpetual motion effect, I eventually came to assume that he must be exaggerating, or dramatizing a hypothetical theory he wanted me to test out for him. But now, ten years later, my search for the self-fueling air car has brought me full circle, back to a working theory that I could almost have written from the notes I took that night at George Heaton's dining room table. The part George left out, the scientific explanation, would have become clear to me if I'd done any research on my idea of running cars on loudspeakers. If I'd studied the theory of sound waves more thoroughly when I was in piano tuning school, or when I was working in the pipe organ factory, it would have been obvious what I had to do to manifest the ideas that George left with me. In the meantime, believing that I didn't know how to design a self-fueling air car led me on a fascinating search through the nooks and crannies of compressed air history and pneumatic options. Each stumbling block along the way turned out to have not only a solution, but a really exciting solution that often turned out to be an advantage. I could only know so much about compressed air before becoming permanently interested in it. Each new finding has revolutionized my conception of what compressed air can do. Some of the most often-mentioned of compressed air's supposed disadvantages have turned out to be---from a new point of view---real advantages, and even sources of power.

June 17, 1958 G. A. GILLEN 2,839,269

AIR TURBINE MOTOR FOR MOTOR VEHICLES

Filed March 7, 1955

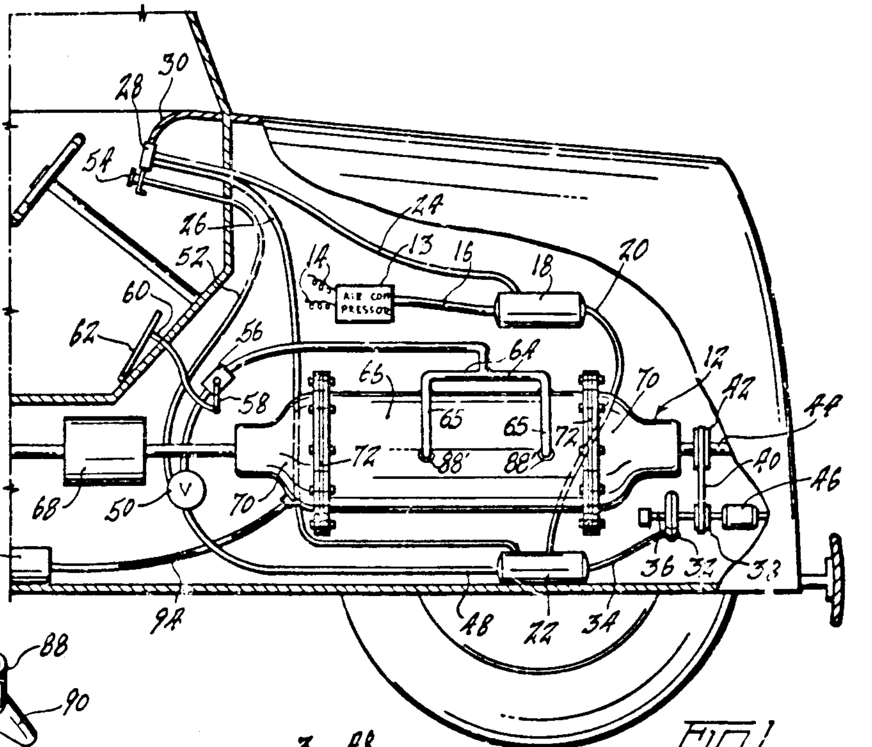


Fig. 1

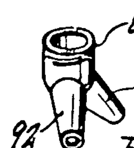


Fig. 4

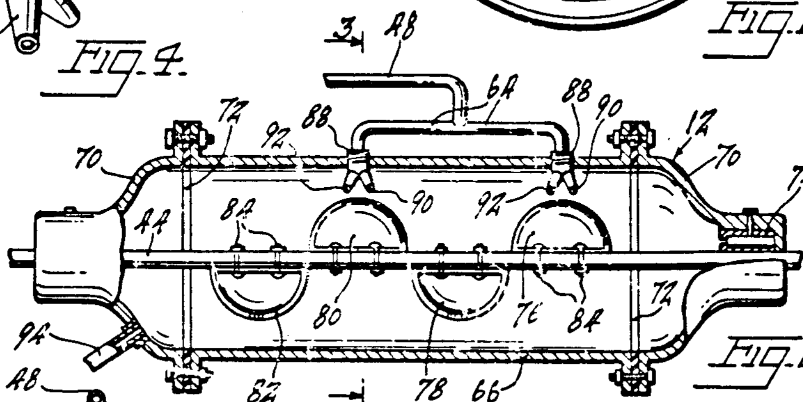


Fig. 2

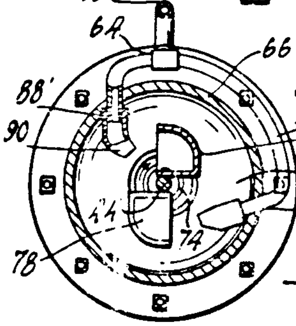


Fig. 3

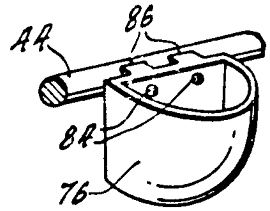


Fig. 5

INVENTOR
GEORGE A. GILLEN
BY
[signature]
ATTORNEY

United States Patent Office

2,839,269

Patented June 17, 1958

2,839,269

AIR TURBINE MOTOR FOR MOTOR VEHICLES

George A. Gillen, Jersey City, N. J.

Application March 7, 1955, Serial No. 492,579

1 Claim. (Cl. 253—55)

This invention relates to vehicle motors, and more particularly has reference to a turbine type motor driven by compressed air, and adapted for powering a suitable vehicle, such as an automobile.

A main object of the present invention is to provide a motor that will be operated at considerably less cost than that required for the operation of a conventional internal combustion engine.

Another object is to provide a highly simplified motor construction, capable of manufacture at a cost considerably less than that required in the manufacture of a conventional internal combustion engine.

Still another object is to provide an air turbine for incorporation in the driving mechanism of a vehicle, which turbine will be so designed as to include a novelly formed and arranged series of nozzles, adapted to direct jets of air under high pressure against a longitudinal series of buckets or scoops carried by the drive shaft.

For further comprehension of the invention, and of the objects and advantages thereof, reference will be had to the following description and accompanying drawings, and to the appended claim in which the various novel features of the invention are more particularly set forth.

In the accompanying drawings forming a material part of this disclosure:

Fig. 1 is a largely diagrammatic view, partly in section and partly in elevation, of the front portion of an automobile equipped with an air turbine motor formed in accordance with the present invention.

Fig. 2 is an enlarged longitudinal sectional view through the turbine.

Fig. 3 is a transverse sectional view through the turbine taken substantially on line 3—3 of Fig. 2, on a scale enlarged above that used in Fig. 2.

Fig. 4 is an enlarged perspective view of one of the nozzles of the turbine.

Fig. 5 is an enlarged, fragmentary perspective view of the drive shaft, and of one of the bucket-like turbine blades carried thereby.

An automobile 10 is illustrated in Fig. 1, provided with an air turbine motor generally designated 12, formed in accordance with the invention.

The motor includes a per se conventional, electrically operated air compressor 13, having conductors 14 extending from a source of electric power, not illustrated, such as a heavy duty automobile battery or series of batteries.

Air compressed by the compressor 13 is forced through a length of tubing 16 to a first reservoir 18 connected by a conduit 20 to a second air reservoir 22. Extending from the respective reservoirs are lines 24, 26 to a double pressure gauge 28 mounted upon the instrument panel 30 of the vehicle. The gauge 28 will be provided with a pair of index arms, each operatively associated with one of the lines 24 or 26, so that the pressure in both reservoirs can be readily determined by the operator of the vehicle at any time.

A conventionally constructed air pump 32 of the rotary

type has an outlet line 34 extending to the reservoir 22, and is driven by a shaft 36 mounted in suitable bearings carried by a selected structural member of the vehicle. A driven pulley 38 is fixed to the shaft to rotate the same, and is driven by a belt 40 trained about a drive pulley 42 keyed or otherwise secured to the vehicle drive shaft 44.

Also driven by the shaft 36 in a conventional generator 46, which would be electrically connected in the circuit including the source of electric power and the air compressor, for the purpose of generating electricity which may be used to supply a part of the requirements of the air compressor.

To the outlet of the second reservoir 22 is connected a main turbine supply line 48, intermediate the ends of which there is provided a valve 50. The valve 50 is a main control valve, which can be used to shut off the flow of air under pressure through the line 48, and can be manually operated from the passenger or operator's compartment of the vehicle, through the medium of a flexible steel cable extending through a housing 52 and connected to a push-pull knob 54 mounted on the instrument panel 30.

Also connected in the line or conduit 48 is a butterfly valve 56, to the shaft of which is secured a radial arm 58 connected to one end of a flexible steel cable 60 the other end of which is connected to the accelerator pedal 62 of the vehicle. On depression of the accelerator, the valve 56 opens the conduit to a selected extent, to regulate the quantity of air flowing therethrough. In other words, when the accelerator is depressed to its maximum extent, the valve 56 is fully opened. When, on the other hand, the accelerator is in its opposite extreme position, the valve 56 is closed. Intermediate positions of the accelerator have the result of partially opening the valve 56, as will be readily understood.

At its discharge end, the conduit 48 opens into oppositely extending branch conduits 64, 64 and 65, 65 opening within an elongated, cylindrical turbine housing 66.

The drive shaft 44 extends axially within the housing 66, and projects out of the rear end of the housing, the shaft extending into a conventional gear box 68 having first, second, third, and reverse gears, controlled by a suitable hand lever, not shown, from within the vehicle, in the same manner as the gears of a vehicle powered with an internal combustion engine. From the gear box, the shaft extends longitudinally of the vehicle, and would be drivingly connected to selected driving wheels of the vehicle in the usual manner.

The cylindrical turbine housing 66, at its opposite ends, is formed with tapered heads 70 flanged at their larger ends for connection to end flanges on the cylindrical body portion of the housing. Compressible sealing gaskets 72 are interposed between the flanges to prevent leakage of air.

At their smaller ends, the heads 70 have bearing cups in which are mounted roller bearings 74 each of which is equipped with a grease fitting. The ends of the turbine housing can, and in a commercial embodiment undoubtedly would, be provided with packing glands through which the shaft 44 extends, to prevent leakage of air from the ends of the turbine housing.

Within the cylindrical body portion of the turbine housing, the shaft 44 has bucket-like turbine blades 76, 78, 80, 82 secured thereto. As will be seen from Fig. 2, alternate ones of the blades are aligned longitudinally of shaft 44, to provide longitudinal rows of the turbine blades, the blades of one row being angularly spaced 180° circumferentially of the shaft 44 from the blades of the other row. In other words, the blades 76, 80 are aligned with one another and the blades 78, 82 are also aligned with each other, with blades 76, 80 being spaced 180° from blades 78, 82 alternating therewith.

Any number of turbine blades can be provided, four being illustrated by way of example.

All the blades are identically formed, so the description of one will suffice for all. As shown in Fig. 5, blade **76** is secured to shaft **44** by bolts **84** passing through diametrically extending openings of the shaft, and at the location of the bolt-receiving apertures of the turbine blade, the outer surface of the blade is formed with lugs **86** having arcuate surfaces complementing the arcuate surface of the shaft **44** to provide a strong connection that will insure against shearing of the bolts **84** when the blades are secured to the shaft. Each blade at the side thereof adjacent the shaft is of rectangular formation, and the rectangular inner side of each blade merges into a portion at the outer side of the blade that is formed as a one-fourth segment of the sphere.

Associated with the blades **76, 78** to direct air thereagainst are nozzles **88, 88,** said nozzles being secured to the ends of the branch pipes **64, 64,** on one side of the drive shaft **44,** while similar nozzles **88', 88'** are arranged to direct air against the blades **80, 82,** said nozzles **88', 88'** being connected to the ends of branch pipes **65, 65,** on the other side of the drive shaft. The nozzles are identical, each including an exteriorly threaded body threaded into a complementarily threaded opening of the body portion of the turbine housing. At its inner end, the body of each nozzle tapers, and integral with the tapered portion of each nozzle is a pair of divergent nozzle members **90, 92** tapering in a direction from the body of the nozzle. The nozzle members of each nozzle lie in a common plane oblique to a plane including the axis of the body of the nozzle. Since the axis of the nozzle body intersects perpendicularly with the axis of the shaft **44,** the nozzles are pointed to one side of shaft **44** (Fig. 3) to direct jets of air along paths diverging in a direction away from the nozzle members, with each jet path extending as a chord of the turbine housing when the turbine housing is seen in cross section as in Fig. 3.

As a result the nozzle members **90** and **92** of nozzles **88** direct jets against the concave surfaces of the blades **76** and **80** on one side of the shaft **44** to drive the shaft clockwise as viewed in Fig. 3, and the nozzle members **90** and **92** of nozzles **88'** direct jets against the concave surfaces of the blades **78** and **82** for driving the shaft in the same direction.

After the air has been directed against the nozzle blades, it is exhausted out of an inlet opening formed in one of the heads **70,** to which outlet opening is connected an exhaust conduit **94** extending to a muffler **96** of the vehicle.

In operation, the air compressor is first operated with the main valve **50** closed, until air has been built up within the reservoirs **18, 22** to a selected pressure. Thereafter, the main valve is opened, and air will flow through the reservoirs, passing through the main supply conduit **48** to rotate the shaft **44.** The shaft will be rotated at a selected rate of speed, by adjustable positioning of the butterfly valve **56** operable by depression of the accelerator pedal **62.** The accelerator pedal, as will be understood, will be provided with a spring tending to shift the accelerator pedal to its outermost position and in this position of the accelerator pedal, the butterfly valve **56** will be closed.

When the shaft **44** is rotated by air forced against the turbine blades, jack shaft **36** will also be rotated, driving pump **32** which aids in pumping air to the compressed air reservoirs. Further, the generator **46** will now be driven, to supply a part of the requirements of the air compressor. Periodically, the air compressor may be stopped, even though the vehicle is in operation, whenever the air builds up to a predetermined pressure exceeding normal requirements.

While I have illustrated and described the preferred embodiment of my invention, it is to be understood that I do not limit myself to the precise construction herein disclosed and the right is reserved to all changes and modifications coming within the scope of the invention as defined in the appended claim.

Having thus described my invention, what I claim as new, and desire to secure by United States Letters Patent is:

In a fluid pressure turbine, an elongated hollow cylindrical housing closed at its ends by heads, said housing having a pair of spaced inlets at the top for passage of air fluid into the housing and having an outlet at the bottom in one of said heads for the discharge of said fluid from the housing, a rotor disposed in said housing centrally thereof, leaving a space therearound, said rotor including a shaft disposed axially of the housing and pairs of curved bucket-like blades spaced and secured along the shaft, the blades of each pair being disposed in opposite directions, a supply of motive fluid, pairs of nozzles disposed in said inlets for injecting said motive fluid into the housing against the surfaces of the blades, one pair of nozzles injecting motive fluid against the blades of one pair of blades, the other pair of nozzles injecting motive fluid against the blades of the other pair of blades.

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REALISTIC?

Fantastic Ideas In Coulee Shack

By HU BLONK

GRAND COULEE — "The Fantastic Inventor from Coulee Center" — so labeled in the last Daily World story about him 10 years ago — is back in Grand Coulee after years in Washington, D.C.

At 72, Greek - born Constantinos Vlachos has lost none of the enthusiasm he's always had for the startling inventions that federal bureaucrats and major gas and oil companies, according to him, have been trying to keep off the market.

If he corners you in a tidy little shack off the Spokane-Grand Coulee highway, he'll fill you full of facts about:

1. An engine-less automobile that will run for almost nothing on castor oil or a chemical called fluoro-carbon; a car that would have magnetic devices on it to keep other cars from running into it.

2. A special plane that would permit waging war without hurting anyone — by hurling up to 4,800,000 million ether pellets an hour at the enemy, and then allowing a ground force simply to walk in and carry out the soldiers knocked out.

3. A combination car - boat-airplane that looks like a motorized beach umbrella, a sort of wordly flying saucer.

4. A greaseless pump that that needs no oiling or greasing; that could vary the volume of liquid it sucks up; a pump that's reversible and would involve no bearings or priming.

5. A pilot-less aerial cargo-carrier that could fly from Wenatchee to Hong Kong and back in something less than 15 minutes; that could unload itself overseas and return on its own accord.

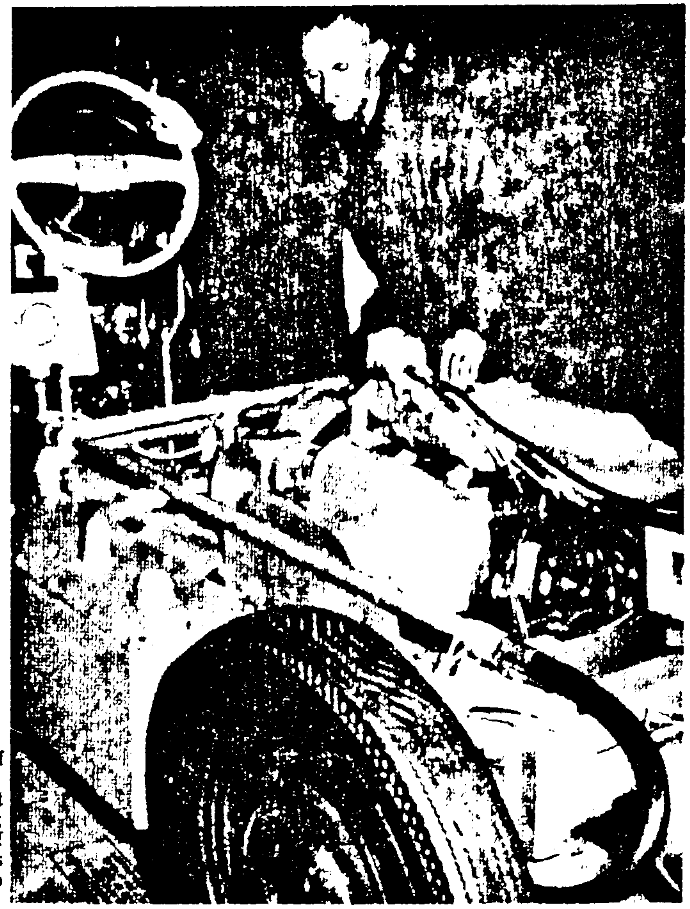
6. A home generator to provide power for the house. It would be driven by the same fluoro - carbon process that would drive the car, and make power for homeowner for almost nothing.

Vlachos has blueprints for all these things, plus the actual car and pump.

But any writer who tries to go into detail on each of these "inventions" soon finds himself.

Thus it sufficies to say:

Vlachos turned on the car, which is only a chassis, and it ran. It was using castor oil, he said. But he prefers fluoro-carbon, something "you can drink like water." It is fed to a midget motor the size of the palm of your hand on each wheel. what happens, said Vlachos (to boil down a thousand words in a sentence or two) is that the chemical liquid is made into gas. As it expands it pushes a piston. Having done that it returns to liquid again. The process is repeated over and over.



OUT OF THE ORDINARY — Here's the car that runs without a regular engine or gasoline. Individual motors, the size of one's palm, are driven by a chemical turned into a gas over and over again. The pipe in the foreground feeds the wheel motor. The car would cost almost nothing to operate, inventor Constantinos Vlachos said, as he turned it on.

The Phibian, said the slim inventor with the crew-cut and tiny mustache, has no gear to shift, no valves to grind, no brakes to whine, no differential no water to freeze, no shock absorbers to repair, no exhaust to breathe (Los Angeles, take note).

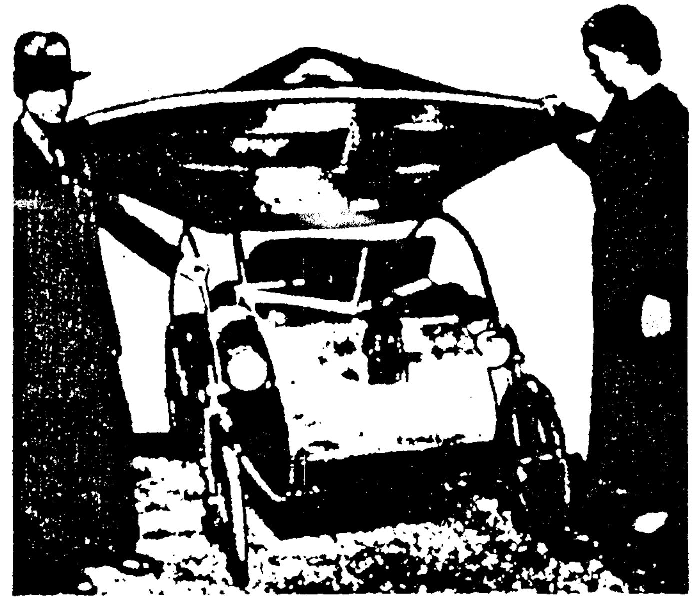
While at Grand Coulee the chassis is jacked up so the wheels can turn, the car once ran successfully on a Vancouver highway, according to a 1950 Oregon Journal clipping.

It says that it "amazed onlookers by doing a 45-mile clip. It not only stunned the spectators but nearly floored a gathering of engineers who swore such a rig was impossible."

The car, said Vlachos, could never be struck, say at an intersection, by another car because the auto would through magnetism reject the other vehicle. Fact is, he said, if you noticed a drunken driver coming at you, you could push a button on your own car and magnetically bring the drunk's car to a stop.

And having said that, we'd better pass on to the combination car-boat-airplane.

Vlachos calls it a Triphibian. It's intended to operate as casually in the air as on land and water. Vlachos demonstrated it years ago in Washington, D.C., according to newspaper clippings, and all but cremated himself. It was sabotage, he's since claimed.



STRANGE CRAFT — This is the combination car-boat-airplane that Constantinos Vlachos invented some years back. In a demonstration on the mall in Washington, D.C., it blew up, almost cremating Vlachos, at left. With him here is Mrs. Vlachos. The inventor claims the flying saucer-like device exploded because of sabotage. He said it once went up 170 feet.

Seated in the cockpit, Vlachos turned on the switch. The Triphibian shuddered several great shudders and errupted in a blinding flash that completely engulfed Vlachos. He spent nine months in the hospital.

"Somebody put gasoline fuel in the wrong fuel line," he said.

Vlachos has never tried to build another one. Why not?

"I'm scared they'd blow me up next time," he said, his face taking on a serious expression.

Switching the discussion to the cargo plane, Vlachos brought out huge, professional-looking blue prints, four by six feet in size. The aircraft would be a folding - winged pilotless aircraft shaped like a rocket, capable of going 170,000 miles an hour.

Used in time of war it would be a weapon for humane war because it would carry bullets that break, Vlachos said. The bullets would be of ether and spray out through nozzles in the propeller vanes. The bullets would hit and stun the enemy but not kill him. Soldiers would just go to sleep for 24 hours or so and during that time our ground forces would disarm them.

Vlachos demonstrated his pumps, which he calls the Vlachos vane-type pumps. It seemed a simple device and gulped up the liquid out of one container and discharged it an another. Then it did it in reverse. Regulation of the volume of flow was also demonstrated.

Other pumps can't do this sort of thing, he said.

Getting back to the home power generator and the car, both are apparently close to perpetual motion.

"They say he's closer to perpetual motion than anyone," Mrs. Vlachos said.

With a bit of sadness in her voice, she added:

"They want a car that doesn't use gas, yet here's a man with so much to offer but he can't seem to get on his feet."

Right now, Vlachos is trying to get federal financing for his project, something he's been unsuccessful at for 30 years.

With the money he'd establish seven factories on the old air base near Moses Lake, he said. One would build his greaseless pump to move liquids, and second would build pumps to extract wheat from ships, a laborious sack - by - sack job now, Vlachos said. Others would build his plane and car.

All he asks is $250 million from Uncle Sam.

PATENT OFFICE
OFFICIAL GAZETTE
December 22, 1964

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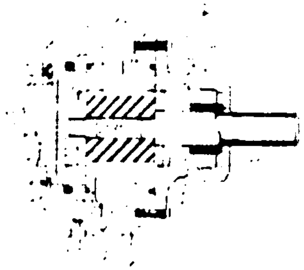
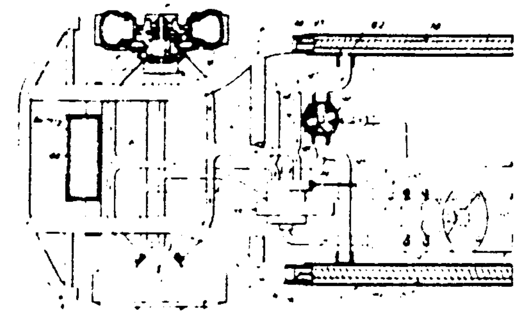
FLUID F[illegible] VICE
Constantinos H. Vlach [illegible] 6, Washington, D.C.
Filed Oct. 4, 19[illegible] No. 228,415
8 Claims. (Cl. 103—136)



1

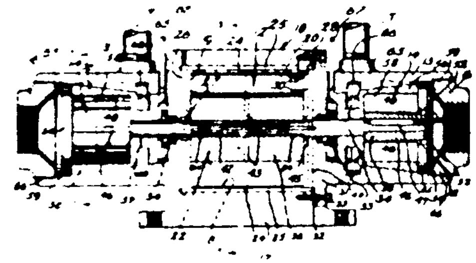
1. A fluid flow device suitable for use either as a pump or motor comprising a casing having an inlet port and an outlet port, said device having a chamber, a rotor disposed in said chamber to provide at least one pump chamber, said pump chamber having an intake port and a discharge port, said device having a first fluid passage means communicating with said inlet port of said casing and said intake port of said pump chamber and a second fluid passage means communicating with said discharge port of said pump chamber and said outlet port of said casing, said rotor shaft being journaled in said device, said rotor having a plurality of slots, each slot having a slidable vane disposed therein, said rotor having a fluid passage means communicating with the bottom of said vane slots and one end of said shaft, a rotatable means mounted in said device having a surface forming an end wall of a pump chamber, said rotatable means having an opening in said surface and a fluid passage means extending from said opening to and communicating with the fluid passage means in said rotor and shaft and means mounted on said device for rotating said rotatable means correspondingly to vary the amount of exposure of said opening to said pump chamber.

61-IV-39 AUTOMOTIVE VEHICLE POWER PLANT, CHASSIS AND RUNNING GEAR - SIC 3711:
Patented (Cl. 180-67)



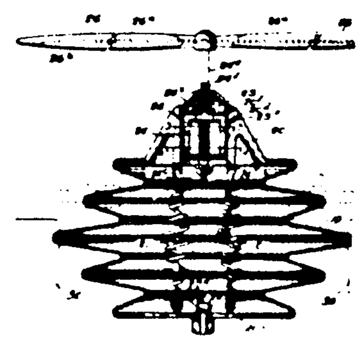
Incorporates a power plant in which a volatile liquid is vaporized by use of electrical energy to provide a gas which at relatively high pressure is supplied to individual reversible motors on each ground engaging wheel. Chassis is formed of tubular members which serve as gas pressure chambers. Exhaust from the motors is condensed and liquid returned to the chambers. The car does not use gasoline. No oil, no grease, no fumes or poison gases. The power and air-conditioning cycle is compounded together in one sealed-in-unit-system to make the complete thermodynamic cycle as quiet and automatic in operation as the modern domestic refrigerator and air-conditioning unit. The application of hydraulic pressure is arranged so that propelling power, service brakes, speed control, power steering and parking brakes are contained in a sealed-in-system.

-IV-31 THERMOHYDRAULIC POWER CONVERTER - SIC 2[illegible]:
Patented (Cl. 103-118)



finned rotor, enclosed in sealed housing; iven by pressured fluid in which the rotor ates, at high speed. One of these units can placed in each vehicle wheel with all driven fluid that circulates through small power it. Temperature of fluid maintained within desired range.

ef. No.
-IV-16 TOY HELICOPTER - SIC 3069:
Patented (Cl. 46-75)



perated by compressed air that is discharged rough jets in trailing edges of propeller blades. ontrolled by string. Can be made in various sizes nd designs suitable for different ages of children nd place of operation.

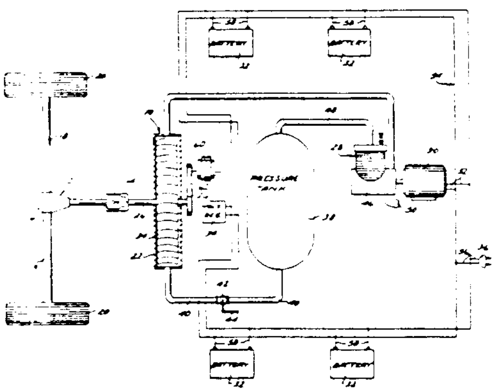
oducts List Circular

—Opportunities for Small Businesses—

PREPARED BY THE RESEARCH AND DEVELOPMENT DIVISION, SBA

APRIL 23, 1968

3,379,008
FLUID PRESSURE SYSTEM FOR OPERATING A VEHICLE DRIVE
Carl A. Manganaro, 1971 El Monte Drive, Thousand Oaks, Calif. 91360
Filed May 5, 1966, Ser. No. 547,838
4 Claims. (Cl. 60—57)

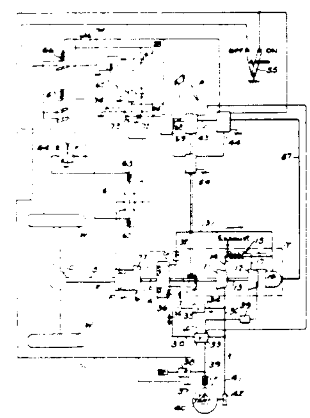


A turbine drive system for propulsion of a vehicle and in which the turbine is driven by air compressed by a compressor which is driven by an electric motor, the motor being operable by batteries in circuit with an alternator which is driven by the turbine.

3,543,873
TURBINE AND ELECTRIC POWERED VEHICLE
William W. Toy, Bloomfield Hills, Michigan, assignor to Lewis G. Harmon, Birmingham, Michigan a part interest
Filed March 19, 1968, Ser. No. 714,268
Int. Cl. B60k 1/04, 17/10
U.S. Cl. 180—65 36 Claims

A combined turbine and electric drive for a vehicle which includes a turbine, an aerodynamic torque converter driven by the turbine, and a motor generator connected to a source of electrical energy and having a rotor connected to the aerodynamic torque converter and the vehicle wheels. The vehicle is driven by the turbine or is driven electrically by the motor generator in the motor mode or simultaneously by

DECEMBER 1, 1970



both and includes automatic switching means to disconnect the energy source from the motor generator under certain conditions.

IN-THE-NEWS! Consumers Guide

Editor skeptical of "Air/Auto" story

(Reprinted from Popular Science Magazine.)

Have you heard about the car that runs on the power stored in permanent magnets and uses no fuel at all? About the one that runs on compressed air; you only have to pump up the tank once then it goes forever? The one that runs on water because a special carburetor splits the oxygen and hydrogen to fuel the engine?

Have you heard about the new carburetors that get two, three, or five times as many miles per gallon as the old carburetors? About all the devices that the car companies are just too stupid or too stubborn to use?

We hear about these "developments" constantly. We get letters from readers daily asking us why we don't cover them. Every time a local newspaper somewhere prints such a story, we are deluged with clippings from readers.

The first thing I should point out is that stories of this kind are not new. I remember my first such experience. I was a young reporter in a small southern town 30 years ago. A man came by and invited local reporters to a demonstration. He filled the gas tank with water, then dropped an aspirin-size pill into the tank. The pill he said, converted the water into a high-energy fuel. He let anyone who wanted to drive the car around, and it certainly did drive like any other car. He explained that the pill was the invention of a brilliant scientist, but that the oil companies were trying to buy up the patents so that they could suppress the invention and continue to sell oil. But he had turned down millions from the oil companies.

I don't know how the guy made the car go. I suppose he had a small, secret gas tank hidden somewhere. But I am convinced that he didn't have a magic pill that made water into automotive fuel. And I'm just as sure that the current generation of secret-engine developers has not found any way around the basic laws of physics. There is no perpetual-motion machine that can create energy out of nothing. And it's very unlikely that there is any way to increase the efficiency of engines by enormous amounts.

You can certainly increase efficiency to some extent. Fuel injection, for example, is more efficient than carburetion since it delivers precisely measured amounts of fuel to the engine. We've printed articles in "Popular Science" about products that vaporize gasoline more fully and increase fuel economy. But these devices all make relatively modest improvements. Anytime you read about increasing gas mileage many times, you're probably hearing about a device that claims to get more energy out of the fuel than it contains.

Someday, someone may invent a far more efficient method of energy conversion than anything we know now. Someday, someone may succeed in finding new laws of physics that replace or supercede those we use now. But until someone can offer substantial proof that something of this kind has happened, we'll remain skeptical. We'll continue to keep an eye on developments and report those that seem promising. But we won't be impressed by the guy with the gas-tank pill, or by his modern-day descendants.

C.P. Gilmore
Editor

Lee Iacocca has also stated in print (Omni Magazine?) that air cars are nothing but perpetual motion machines.

March 17, 1970 W. W. TOY **3,500,637**

GAS TURBINE ENGINE WITH AERODYNAMIC TORQUE CONVERTER DRIVE

Filed Jan. 26, 1968 2 Sheets-Sheet 1

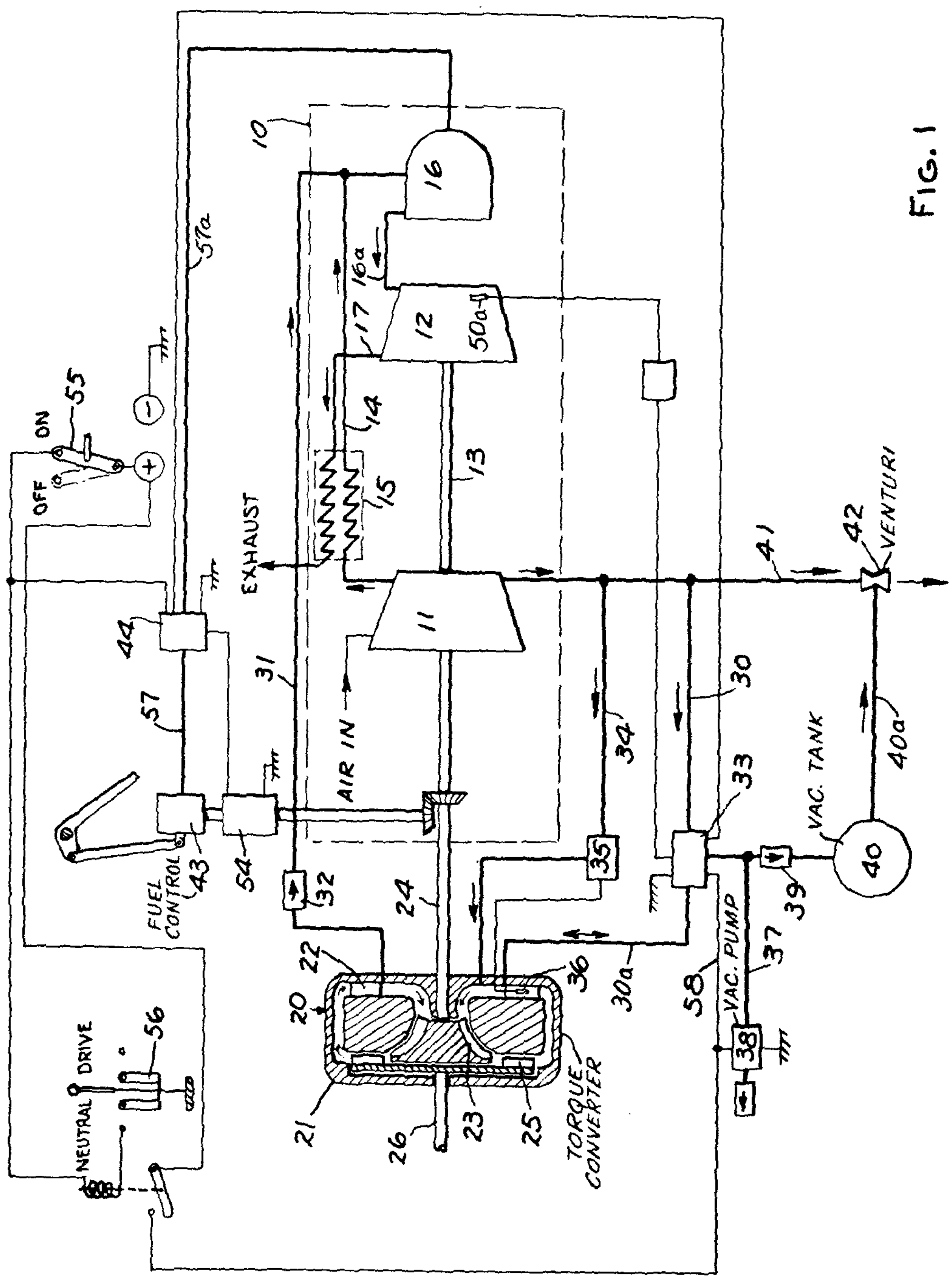


FIG. 1

INVENTOR.
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BY
Barnes, Kisselle, Raisch & Choate
ATTORNEYS

March 17, 1970 W. W. TOY 3,500,637

GAS TURBINE ENGINE WITH AERODYNAMIC TORQUE CONVERTER DRIVE

Filed Jan. 26, 1968 2 Sheets-Sheet 2

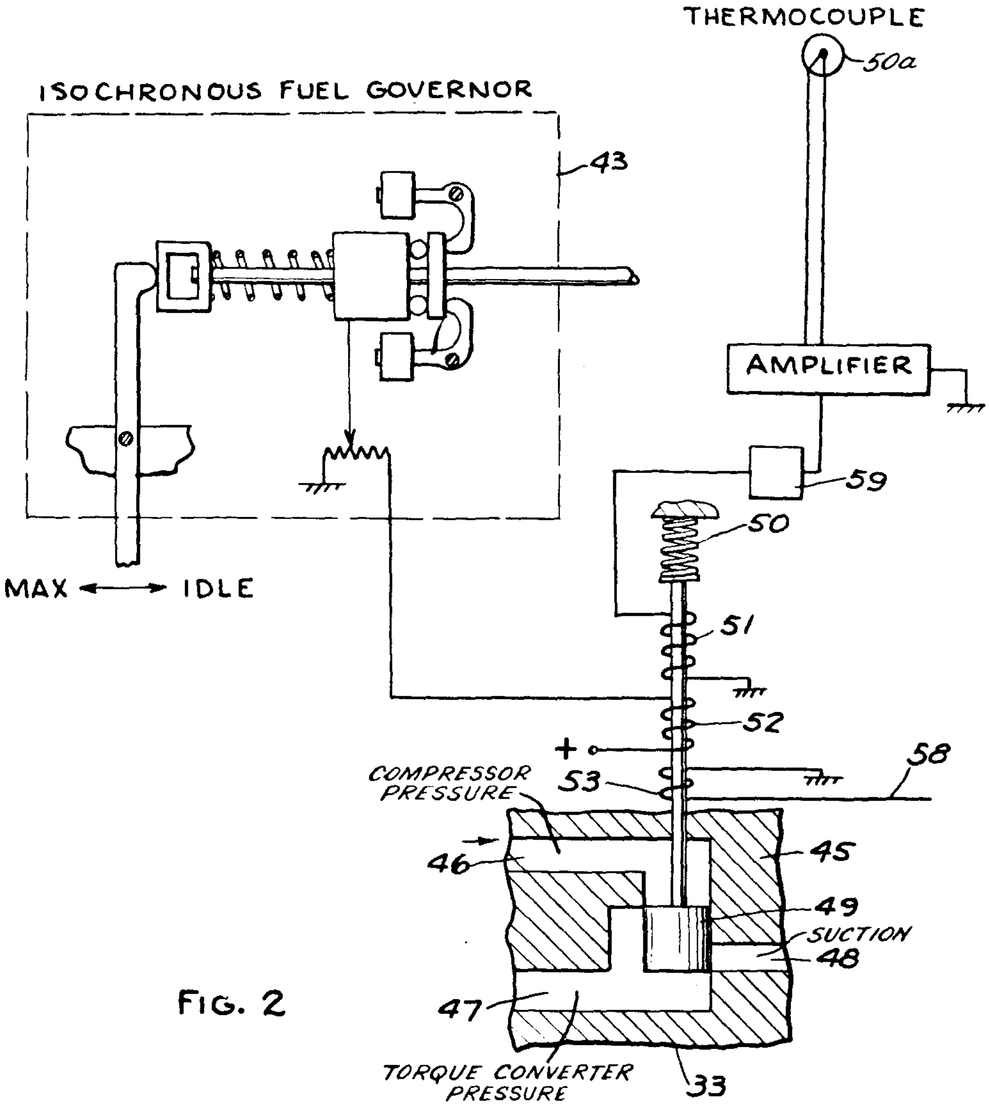

FIG. 2

INVENTOR.
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BY
Barnes, Kisselle, Raisch & Choate
ATTORNEYS

PO-1050
(5/69)

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,500,637 Cl. 60 Dated March 17, 1970

Inventor(s) William W. Toy

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPECIFICATION:

Column 2,

line 52, after "from" insert --the line 30-- ;

Column 3, line 26, after "pump" insert --38-- ;

line 38, change "finaly" to --finally-- ;

Column 4, line 5, change "substantialy" to --substantially-- ;

line 37, change "presure" to --pressure-- ;

line 64, change "presure" to --pressure-- ;

line 70, change "presure" to --pressure-- ;

Column 5, line 1, change "presure" to --pressure-- ;

line 5, change "presure" to --pressure-- ;

line 6, change "presure" to --pressure-- .

SIGNED AND SEALED

AUG 4 - 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

United States Patent Office

3,500,637

Patented Mar. 17, 1970

1

3,500,637

GAS TURBINE ENGINE WITH AERODYNAMIC TORQUE CONVERTER DRIVE

William W. Toy, Bloomfield, Mich., assignor of fifty percent to Lewis G. Harmon, Birmingham, Mich.

Filed Jan. 26, 1968, Ser. No. 700,942
Int. Cl. F02b *61/00;* F02g *3/00;* F16d *33/12*
U.S. Cl. 60—39.03 14 Claims

ABSTRACT OF THE DISCLOSURE

A gas turbine engine including a compressor, a turbine, a combustor, and a heat exchanger, is combined with an aerodynamic torque converter. The torque converter has a casing filled with a compressible fluid, namely air, and mechanically includes a stator, an input rotor, and an output rotor which is driven by fluid action upon rotation of the input rotor. The input rotor of the torque converter is connected to and driven by the rotor of said turbine. A first fluid line extends between the outlet of the compressor and a pressure area of the casing of the torque converter. A second fluid line extends from the casing of the torque converter to a point ahead of the inlet to the turbine. A valve in the first fluid line is operable to control the fluid delivery to the torque converter casing and to variably dump fluid therefrom, in response to varying turbine temperature and to pressure differentials between the casing and the compressor outlet, as well as to certain engine speed conditions.

This invention relates to gas turbine engines and particularly to the transmission of power from gas turbine engines to perform work.

In the use of a gas turbine, speed reduction is required since the gas turbine shaft rotates at relatively high speed. Conventional means for achieving speed reduction utilize mechanical gears for reducing the speed, and free power turbines are utilized to achieve substantial power over a wide range of speeds. In the patent to Charles C. Hill 3,314,232, issued Apr. 18, 1967, there is disclosed a gas turbine engine with aerodynamic torque converter drive which utilizes a single shaft gas turbine engine and an aerodynamic torque converter having a casing filled with a compressible fluid. Such a system produces speed reduction without gears or hydraulic converter, effects recovery of transmission losses, provides superior starting and acceleration without the use of variable vanes, and has more desirable low output speed-torque characteristics.

The primary object of the present invention is to provide for such a gas turbine engine with aerodynamic torque converter drive an improved system for controlling the fluid density in the torque converter in accordance with power and load requirements. This control system is relatively simple and easily adjusted, has a rapid response to conditions of engine acceleration and deceleration and will operate with minimum net air bleed from the engine gas cycle to achieve maximum thermodynamic recovery of converter losses and optimum turbine performance.

2

In the drawings:

FIG. 1 is a part sectional diagrammatic view of a gas turbine engine with an aerodynamic torque converter drive embodying the control system of the present invention.

FIG. 2 is a schematic drawing of the control valve and condition signalling components utilized in the system shown in FIG. 1.

Referring to FIG. 1, a conventional single shaft gas engine turbine **10** includes a compressor **11** and a turbine **12** that preferaby have their rotors directly connected as by a single shaft **13**. The major portion of the compressed air from the compressor **11** flows through a line **14** forming a part of a heat exchanger **15** to the combustor **16** of the gas turbine engine **10**. The combustor **16** defines its high temperature gas to the turbine **12** through a line **16***a*. The exhaust gases from the turbine **12** flow through a line **17** in heat exchange relation to the line **14** of the heat exchanger **15**. Basically, the above components are conventional for gas turbine engines.

An aerodynamic torque converter **20** is provided, comprising a casing **21** with fixed guide vanes **22** and an input rotor **23** that is connected by a shaft **24** to the outlet rotor (not shown) of the compressor **11**. The casing **21** is adapted to be filled with compressible fluid, namely air, which is delivered from the compressor so that upon rotation of the rotor **23**, the flow of air exerts a torque on an output rotor **25** to rotate an output shaft **26** of the torque converter **20**. For purposes of clarity, the torque converter has been shown as a single stage turbine having a single output rotor **25** but it may be a multiple stage turbine. Although, the torque converter is preferably shown as an outward radial flow turbine type, axial flow design may also be used.

As further shown in FIG. 1, a first fluid line **30** extends from the discharge side of the compressor **11** to a valve **33**, from which the fluid is variably delivered through a line **30***a* to the interior of the casing **21** of the torque converter **20**. A second fluid line **31** extends from the interior of the casing **21** of the torque converter **20** to the upstream gas cycle side of the turbine **12** and preferably to a point ahead of the combustor **16**. A one-way check valve **32** is provided in the line **31** so that flow can occur in the line **31** only from the interior of the casing **21** to the combustor **16** when the pressure in the casing **21** is higher than the combustor inlet pressure, which in the present case will be substantially the compressor outlet pressure.

The valve **33** between lines **30**, **30***a* operates to direct pressurized air flow from the compressor **11** to the interior of the casing **21** in normal operation. Also, as will be explained, the valve **33** operates to interrupt the flow from and discharge fluid from the casing **21** outwardly from the valve **33**.

Another line **34** extends between the discharge side of the compressor **11** and casing **21** through a valve **35** interposed in the line **34** and responsive to temperature within the casing **21** signalled by a temperature sensitive element **36** in the casing **21** to permit flow of cooling air from the compressor **11** to the interior of the casing **21** when the temperature in the casing exceeds a predetermined value.

As further shown in FIG. 1, a line **37** extends from the valve **33** to a vacuum pump **38** that is operable at start-

ing, as will be described. The valve **33** is also connected through a one-way check valve **39** to a vacuum tank **40**. A sub-atmospheric pressure in the vacuum tank **40** is maintained by operation of a venturi **42** through which a small continuous flow of air is delivered by means of a line **41** extending from the discharge side of the compressor **11** functioning to continuously aspirate air from the tank **40** through a line **40***a*.

The gas turbine engine further includes a manually controlled engine governor and fuel control **43** that is operable to vary the fuel supply through a line **57** to a starting sequence control **44** and in turn through a line **57***a* to the combustor of the gas turbine engine for mixture with and combustion in the air delivered from the compressor **11**.

As previously set forth, the valve **33** is operable to direct flow through the lines **30** and **30***a* between the compressor **11** and the casing **21** or to interrupt the flow so that flow can occur between the casing **21** and exterior of the valve, namely, to the vacuum tank **40**. The valve **33** is shown diagrammatically in FIG. 2 and comprises a valve body **45** having a port **46** that is connected to the line **30** leading from discharge side of the compressor **11**, a port **47** that is connected to the line **30***a* leading to the torque converter **20**, and a port **48** that is connected to the vacuum tank **40** and via the line **37** to the vacuum pump. A piston **49** is provided to control communication between the ports and is shown in the null position. When the piston **49** is operated downwardly from the position shown the ports **46** and **47** are in communication to supply compressor fluid under pressure to the casing **21**. The piston **49** is yieldingly urged into the down position by a spring **50**. The piston **49** is moved upwardly from the position shown in opposition to the biasing action of the spring **50** in response to a temperature signal of the turbine **12** applied by a coil **51** connected with a thermocouple **50***a* to variably throttle the flow from port **46** to port **47** and finaly interrupt the flow. Further upward actuation of the piston **49** will open communication between the ports **47**, **48** to exhaust fluid from the casing **21**. The temperature signal of the turbine thermocouple **50***a* is modified by the first derivative of temperature in respect to time in a first derivative feed back unit **59** in order to minimize or eliminate overshooting of the response relative to a selected turbine gas temperature during rapid temperature excursions.

In addition, the piston **49** is moved upwardly in response to a signal applied by a coil **52** energized from the engine governor and fuel control **43** which measures the difference between the speed setting of the control **43** and the actual speed of the turbine **12** effecting piston **49** movement in opposition to the biasing action of the spring **50** to also modulate the flow to and from the torque converter casing **21**. A further force is applied to the piston **49** by the differential in pressures between the ports **46** and **47** acting on the opposite sides of the piston **49**.

Valve **33** is thus responsive to (1) the temperature of the turbine **12**, (2) the pressure differential between the compressor and the casing **21** of the aerodynamic torque converter **20**, and (3) the difference between the speed setting of the control **43** and the actual speed of the turbine **12**.

OPERATION

In order to start the gas turbine engine **10**, a control **56** is first moved to its neutral position, and an on-off control **55** is moved to the "on" position to actuate a sequencing control **44** and energize a starting motor **54** to start the gas turbine engine **10** in accordance with well-known practice. Simultaneously, in this position, the vacuum pump **38** is started and a coil **53** is energized to operate the valve **33** upwardly to the position wherein communication is provided between the ports **47** and **48** and communication between the ports **46** and **47** is closed. This permits the vacuum pump **38** to evacuate the casing **21** of the torque converter **20** while the check valve **32** and the valve **33** block prevents flow from the compressor into the torque converter casing **21**. Under this condition, the valve **35** would permit flow only if necessary to cool the casing. In this mode, the torque converter **20** is acting in effect to substantialy declutch the shaft **26** from the shaft **24** with very little if any torque being transmitted. Compressor losses, if any, are very small and the flow through valve **35**, if any, is very small.

In any selected position of the fuel control **43**, fuel as required will be fed through the lines **57** and **57***a* to the combustor **16** of the gas turbine engine **10** and the turbine **12** will function. In order to transmit torque to the shaft **26**, the control **56** is moved to the drive position to stop the vacuum pump **38** and de-energize the coil **53**. The piston **49** of the valve **33** now moves down by spring **50** pressure to provide communication between the ports **46** and **47**, directing fluid to the torque converter casing **21** until the density therein attains its maximum value. The manual control **43** can then be moved to any desired speed position. As the temperature of the turbine rises toward an optimum predetermined value, a signal from the thermocouple **50***a* will be provided moving the piston **49** of the valve **33** to throttle or modulate the flow between the ports **46** and **47**, varying fluid flow from the compressor **11** to the casing **21** of the torque converter **20**. As the turbine temperature further rises, the piston **49** will finally interrupt the flow and possibly even open communication between the ports **47** and **48** to permit flow from the casing **21** of the torque converter **20** outwardly to the vacuum tank **40**.

As the piston **49** moves upwardly closing the flow path between the ports **46** and **47**, the presure differential on the piston is only that due to the throttling effect but as the piston moves to reduce the pressure in the casing to the required level, a pressure differential will exist between ports **46**, **47** so that the valve **33** will be sensitive to the presure within the casing as it is opening communication between ports **47** and **48**.

Thus, since the valve **33** is pressure sensitive, it will respond to the pressure condition within the casing **21** of the torque converter **20** and thereby produce a pressure therein proportionate to the signal it is receiving. More effective and accurate control of the system is made possible by the sensitivity of the valve **33** to pressure within the torque converter **20**.

The action of the piston **49** is further modulated by a signal from the control **43** produced by monitoring the difference between the setting of the control **43** and the actual speed of the turbine **11**. During acceleration, a signal will be transmitted to tend to move the piston upwardly against the action of the spring, thus throttling the flow between the compressor and the casing **21** of the torque converter **20**, to limit bleed-off from the compressor **11** and thus maintain maximum efficiency of the engine gas cycle. If the magnitude of the signal is sufficient, the piston **49** may move to a point where flow will be permitted from the casing **21** to the vacuum tank **40**. In the case of deceleration, the signal from the control is in the opposite direction causing the piston **49** to move downwardly and provide full pressure flow to the casing **21**, thereby increasing the output load on the turbine, the torque converter **20** acting as a brake.

When the piston **49** has moved to a position permitting flow from the casing **21** to the vacuum tank **40** and a new presure differential is established, the piston **49** will be urged by the spring downwardly, as viewed in FIG. 2, to interrupt the flow from the casing **21** to the vacuum tank **40**. At this point in time, there will be no flow into the casing and, as the temperature of the fluid therein rises, the presure will also rise causing the piston to throttle between ports **47** and **48** and maintain the pressure differential. At this point, the input torque capacity of the aerodynamic torque converter **20** is slowly being reduced because of the lowering of the density within the converter, which in turn is caused by raising the temperature

of the air at essentially constant presure. As the temperature rise is a slow phenomena, there is time now for sensing the loss in capacity of the torque converter from the turbine **12** temperature and the valve **33** will be signalled for a continuing higher presure until the torque converter presure is sufficient to permit flow in line **31** past the check valve **32** to the connection with the combustor **16** upstream of the turbine **12**, thereby recovering the thermodynamic losses of the torque converter **20**.

In all conditions of the system, if the temperature in the casing as sensed by the sensor **36** exceeds a predetermined value, the valve **35** will open to permit cooling air flow from the compressor **11** to the casing **21** to protect the materials of the torque converter. This is also a slow phenomena permitting time for the cooling effect upon the density of the air within the converter **20** and the associated increase in capacity of the converter **20** to be sensed from the temperature of the turbine **12** and compensated for by the valve **33**.

The control system heretofore described has the following advantages:

(1) The system minimizes the net bleed of air from the gas turbine engine by trapping the volume of air in the converter between the check valve **32** and the valve **33** when it is necessary to bleed air from the converter to drop the pressure so that there will be a fast response. The net bleeding of air from the engine gas cycle through the converter is done only when the torque converter is at its maximum temperature and further reduction of density within the converter is not practical by temperature change. Since the full effect of temperature in reducing the torque capacity of the converter **20** is attained when the converter is at its maximum temperature, the work into the converter is low and therefore the converter's losses are low and the amount of air to cool the converter is proportionally small.

(2) The system provides for rapid accurate changes in torque capacity of the converter in response to signals from various elements in the system.

(3) The system facilitates a rapid acceleration of the gas turbine engine by reducing the output load on the turbine **11** when there is a sudden increase in speed setting.

(4) The system provides for proportioning the load on the gas turbine engine to reduce the torque capacity of the aerodynamic torque converter an amount necessary for the turbine to provide its remaining power to other loads driven directly by the turbine.

(5) The system utilizes only two powered valves and all other valves are check valves.

(6) The system utilizes a vacuum pump that provides an effective clutch in addition to reducing the drag during the starting cycle.

(7) The system provides for maintaining any desired turbine inlet or exhaust temperature schedule with variations in load thereby improving the part load fuel economy.

I claim:

1. A control system for a gas turbine engine with an aerodynamic torque converter drive wherein said engine includes a combustor delivering high temperature gas to a turbine which drives a compressor delivering compressed fluid to the combustor, and said torque converter includes a casing filled with compressible fluid delivered through a first fluid line from the discharge side of the compressor, with a second fluid line for returning fluid from the casing to the engine gas cycle upstream of the turbine, an input rotor in said casing and connected to be driven by said turbine, and an output rotor in said casing and driven by fluid action upon rotation of said input rotor to deliver torque relative to the density of the fluid in said casing, said control system being operable to vary said density and comprising

(a) valve means in said first fluid line operable to variably direct fluid flow from the compressor to said torque converter casing or to variably direct fluid flow from said torque converter casing to atmosphere,

(b) temperature responsive means sensing turbine operating temperatures and operably connected with said valve to actuate same as turbine temperature increases to a selected value to variably throttle fluid flow from the compressor to said casing and on increase above said selected value to interrupt fluid from the compressor and variably divert fluid from said casing to atmosphere.

2. The system as defined in claim **1** wherein said valve means senses pressure differential between the compressor and the casing and operates to variably close communication therebetween relative to pressure rise in said casing.

3. The system as defined in claim **1** including means biasing said valve means toward a position opening communication between the compressor and the casing.

4. The system as defined in claim **1** and including means sensing predetermined temperature rise of said torque converter and operable thereupon to deliver cooling fluid from said compressor to said casing independently of operation of said valve means.

5. The system as defined in claim **1** and including

(a) speed control means variably delivering fuel to said combustor to vary turbine speed, and

(b) means responsive to the difference between the setting of said speed control means and actual turbine speed and connected with said valve means to operate same in a manner to reduce the torque converter load to assist turbine acceleration and increase the torque converter load to assist turbine deceleration.

6. The system as defined in claim **1** including sub-atmospheric means connected with said valve means and operable to effect rapid diverting of fluid from said casing to atmosphere.

7. The system as defined in claim **6** in which said sub-atmospheric means comprises a vacuum tank and a venturi operated by discharge from said compressor to evacuate said tank during engine operation.

8. The system as defined in claim **1** and including means operable on starting said engine to reduce pressure in said casing to sub-atmospheric.

9. The system as defined in claim **8** and in which said last mentioned means comprises a vacuum pump connected with said valve means and connected thereby with said casing only upon starting said engine.

10. The system as defined in claim **1** and including a check valve in said second line operable to permit flow from the casing to upstream of the turbine when fluid pressure in said casing exceeds fluid pressure upstream of said turbine.

11. In a gas turbine engine with aerodynamic torque converter drive system wherein said engine includes a combustor delivering high temperature gas to a turbine which drives a compressor delivering compressed fluid to the combustor, and said torque converter includes a casing filled with compressible fluid delivered through a first fluid line from the discharge side of the compressor, with a second fluid line for returning fluid from the casing to the engine gas cycle upstream of the turbine, an input rotor in said casing and connected to be driven by said turbine, and an output rotor in said casing and driven by fluid action upon rotation of said input rotor to deliver torque relative to the density of the fluid in said casing, and means sensing turbine operating temperature, the method of controlling the system which comprises modulating fluid flow in said first fluid line in response to variations in the operating temperature of said turbine, and variably diverting fluid from said casing to atmosphere in response to rise in turbine operating temperature beyond a predetermined valve.

12. The method as defined in claim 11 and including the step of modulating fluid in said first fluid line in response to variations in pressure differential between the compressor and the torque converter casing.

13. The method as defined in claim 12 and including the step of diverting fluid from said casing as the pressure differential of casing pressure over compressor discharge pressure exceeds a predetermined value.

14. The method as defined in claim 11 wherein said system includes means sensing differences between desired and actual turbine speeds, the step of modulating fluid flow to or from said casing relative to said differences to decrease density in said casing for assisting turbine ac-

celeration and to increase density in said casing for assisting turbine deceleration.

References Cited

UNITED STATES PATENTS

3,314,232 4/1967 Hill ---------------- 60—39.24

MARK M. NEWMAN, Primary Examiner

DOUGLAS HART, Assistant Examiner

U.S. Cl. X.R.

60—12, 39.24

Aug. 25, 1970 W. W. TOY 3,525,874

TURBINE AND ELECTRIC POWERED VEHICLE

Filed April 22, 1968

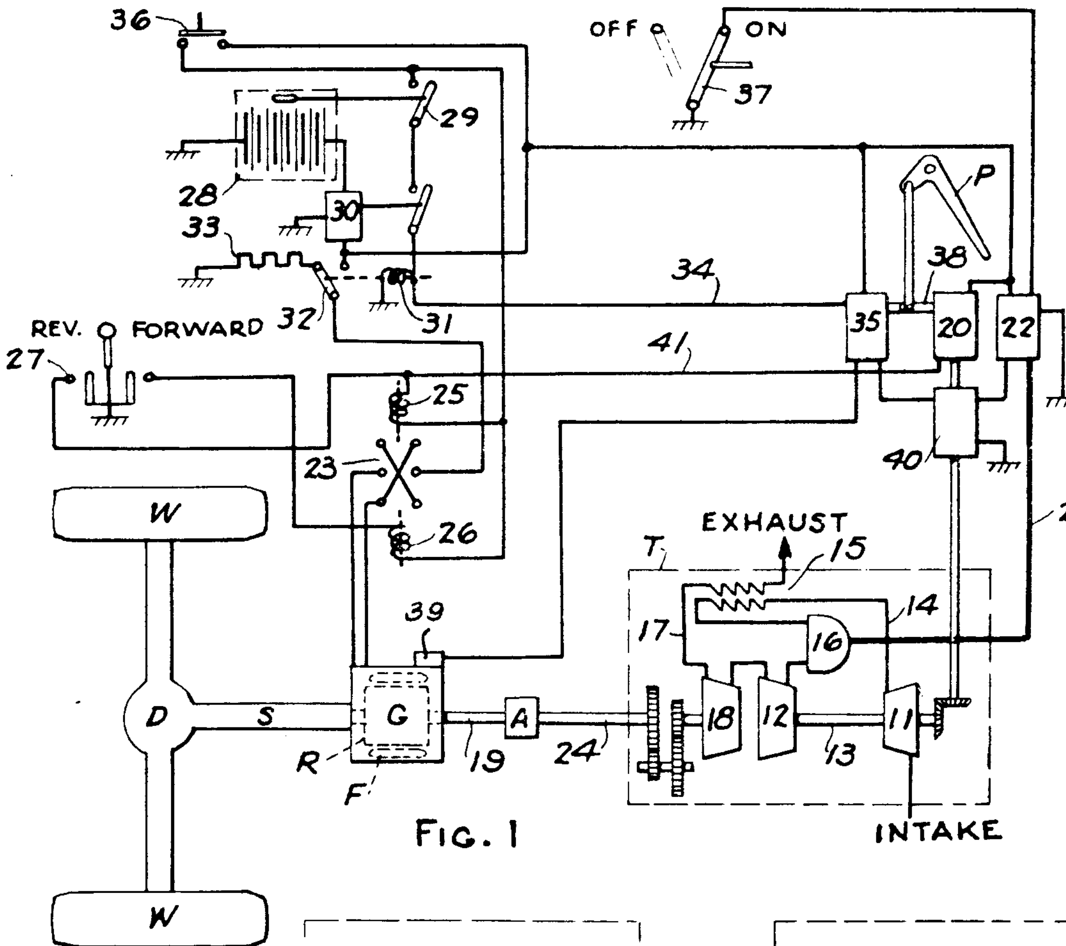

FIG. 1

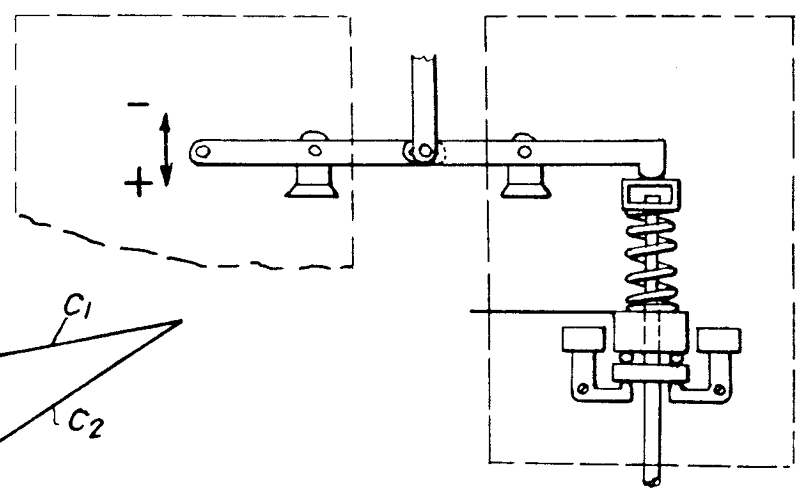

FIG. 2

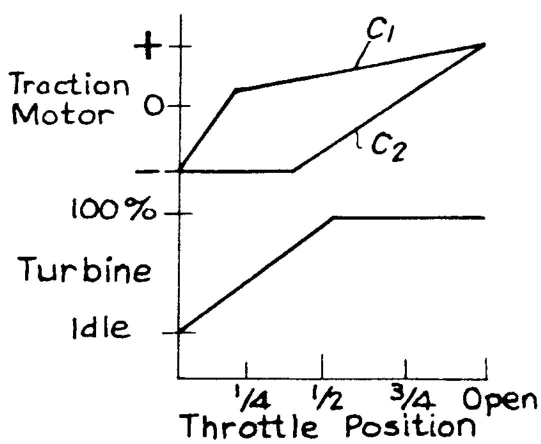

FIG. 3

INVENTOR.
WILLIAM W. TOY
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3,525,874

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3,525,874

TURBINE AND ELECTRIC POWERED VEHICLE

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Int. Cl. B60l 11/12

U.S. Cl. 290—14 4 Claims

ABSTRACT OF THE DISCLOSURE

A combined turbine and electric drive for a vehicle which includes a turbine engine, a clutch driven by the turbine engine, and a motor-generator connected to the clutch and the vehicle wheels. The vehicle is driven by the turbine engine or is driven electrically by the motor-generator in the motor mode or by both.

This invention relates to vehicles and particularly to a drive system for vehicles.

Among the objects of the invention are to provide a combined turbine engine and electric drive for a vehicle wherein the electric drive can be utilized for maximum performance at startup and low speeds and the turbine engine drive can be utilized for maximum performance at higher speeds; which system utilizes a motor-generator that is used to drive the vehicle electrically or to charge the energy source when the vehicle is driven by the turbine engine; which utilizes a novel system for automatically controlling the operation of the turbine engine in conjunction with the electric drive; which provides a power plant with low exhaust pollutant emission when operated as a turbine engine car and zero pollution when operated electrically in congested areas; which provides an electric vehicle with extended range capability due to the recharging of the battery by operation of the turbine engine; and which can also be used as a source of emergency electric power.

In the drawings:

FIG. 1 is a part sectional diagrammatic view of a gas turbine engine and electric vehicle drive system embodying the invention.

FIG. 2 is a schematic drawing of the traction motor control and turbine engine fuel control combination.

FIG. 3 is a graphical representation of the throttle position relative to the traction motor control and turbine engine speed control.

Referring to FIG. 1, the system embodying the invention comprises a turbine engine T which drives a clutch A that, in turn, drives a motor-generator G which, in turn, drives a shaft S extending to a differential D for driving the driven wheels W of the vehicle.

The motor-generator G is of the traction motor type, such as a series wound type, and comprises a stator F and a rotor R, the rotor being directly connected to the clutch as presently described and to the shaft S.

Referring to FIG. 1, turbine engine T comprises a conventional two-shaft free turbine engine which includes a compressor **11** and a first turbine **12** that preferably have their rotors directly connected as by a single shaft **13**. The compressed air from the compressor **11** flows through a line **14** forming a part of heat exchanger **15** to the combustor **16** of the turbine. The exhaust gases from the first turbine **12** flow through a second turbine **18** and through a line **17** adjacent line **14** of the heat exchanger.

As shown in FIG. 1, the output of the second turbine **18** is connected to the input of clutch A. Clutch A is preferably of the overrunning type. The output of clutch A is connected to the shaft of rotor R of the motor generator G. A variable ratio transmission may be installed between the turbine engine T and clutch A in order to provide greater torque over the range of operating speeds chosen for the vehicle than that provided by the electric motor and the straight line output torque vs. speed characteristics of the free turbine engine.

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The motor-generator field of the stator F of the motor-generator G is selectively energized for forward and reverse drive by a two-position switch **23** which is controlled by solenoids **26**, **25**. A hand-operated forward and reverse switch **27** selectively controls the energization of solenoids **26**, **25**. Power for driving the motor-generator in the motor mode is received from an energy source **28** such as a battery.

Suitable controls are provided to prevent abusing the battery **28** by overcharging. A switch **29** responsive to battery temperature is provided for disconnecting the battery **28** from the traction motor-generator G in the event of a thermal runaway or overt-emperature of the battery. A battery analyzer **30** which is positioned to sense both current flow in the battery circuit and the voltage across the battery, provides for disconnecting the battery from the traction motor-generator G when the battery charge reaches a predetermined point. When either sensing device **29** or **30** acts to disconnect the battery, a re-energizing relay **31** moves a switch **32** to connect traction motor G to a resistance **33** which absorbs the energy of regenerative braking and dissipates it as heat. A line **34** signals traction motor control unit **35** of the battery disconnection and the motor control unit **35** schedule is changed. This prevents the regenerative braking feature from dissipating power through the resistance **33** while the turbine is running and acting as a propulsion unit.

An important feature of the system proposed is, that the traction motor G, when acting as a generator, provides rapid charging of the battery **28** thereby minimizing the time it will be necessary to operate the turbine engine for recharge of the battery during moderately slow driving. For fast freeway driving the battery **28** is soon charged, and on demand the circuit reverts to dynamic resistance braking in resistance **33** and the vehicle performs as a turbine propelled car at high speeds receiving little if any of its power from the traction motor G.

OPERATION

The vehicle is made ready for use by closing the ignition switch **36**. With the gas turbine engine switch **37** in the off position, the vehicle functions as an electric battery powered vehicle. It can be charged from the electric utility power while standing still. To drive, the forward-reverse switch **27** is placed in the appropriate position. This pulls in one of the solenoids **25** or **26**. Solenoids **25** and **26** position switch **23** to arrange the traction motor field coils for either forward or reverse operation. The speed and acceleration is adjusted with the foot pedal P which positions an input lever **38** to adjust the mechanical input signal to the traction motor control unit **35**. Unit **39** controls the current flow to the motor-generator G and current in the motor field.

In order to start the turbine engine, the control **27** is in neutral position, the operator places the on-off control **37** in the "on" position which actuates the sequencing control **22** and energizes a starting motor **40** to start the turbine engine in accordance with well-known practice. The turbine engine can also be started with control lever **27** in the forward or reverse position. Line **41** signals turbine governor control unit **20** to idle position when reverse position R is chosen for lever **27**.

In any position of the fuel control unit **20**, fuel will be fed through the line **21** to the combustor **16** of the gas turbine. There will be a tendency to creep when the

free turbine engine is at idle. This effect is overcome by braking. The electric motor provides vehicle propulsion while the free turbine gas generator spool is accelerating from idle to a speed sufficient to produce effective vehicle power. In order to transmit torque, the control **27** is moved to the forward position.

FIG. 3 is a schematic diagram showing the throttle position relative to traction motor control and turbine engine speed control, the lower curve showing the turbine engine speed and the upper curves showing the relationship of the traction motor operation to throttle position, the minus sign indicating regenerative braking or generator operation and the plus sign indicating motor operation. As seen by these curves, as long as the battery is not fully charged, the traction motor-generator will follow the curve C_2. However, if due to operation of the turbine engine the battery is fully charged, the motor-generator will follow curve C_1.

I claim:

1. In a vehicle drive system the combination comprising:

a vehicle having at least one driven ground engaging wheel,

a free turbine engine having a combustor, a compressor, a first turbine having a rotor and a stator, and a second turbine having a rotor and a stator, said rotor of said first turbine being drivingly connected to said compressor; said rotor of said second turbine being fluidly driven by said first turbine and having an output shaft,

an automatic overrunning clutch device between said turbine engine and said driven wheel,

said clutch having an input shaft and an output shaft which is driven upon rotation of said input shaft,

said input shaft of said clutch being drivingly connected to said output shaft of said rotor of said second turbine,

a motor-generator connected to a source of energy and including a stator and a rotor,

said rotor being connected to the output shaft of said clutch and to the driven wheel of the vehicle, and

means automatically responsive to load conditions to vary the output of said motor-generator relative to said turbine engine.

2. The combination set forth in claim **1** including means for electrically connecting said energy source and said motor-generator for operating said motor-generator as a motor,

and means for de-energizing said last-mentioned means and actuating said turbine to reverse the operation of the motor-generator so that it operates as a generator to supply current to the energy source.

3. The combination set forth in claim **1** including a differential interposed between said clutch and said driven wheel.

4. The combination set forth in claim **1**, said load condition responsive means including means for controlling the supply of fuel to said turbine and for controlling the supply of electrical power to said motor-generator such that when said means is positioned for acceleration said motor-generator is operated as a motor and fuel is supplied to said turbine to bring said turbine up to the desired speed and wherein thereafter said means is positioned for the operating speed, said motor-generator is operated as a generator.

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G. R. SIMMONS, Primary Examiner

U.S. Cl. X.R.

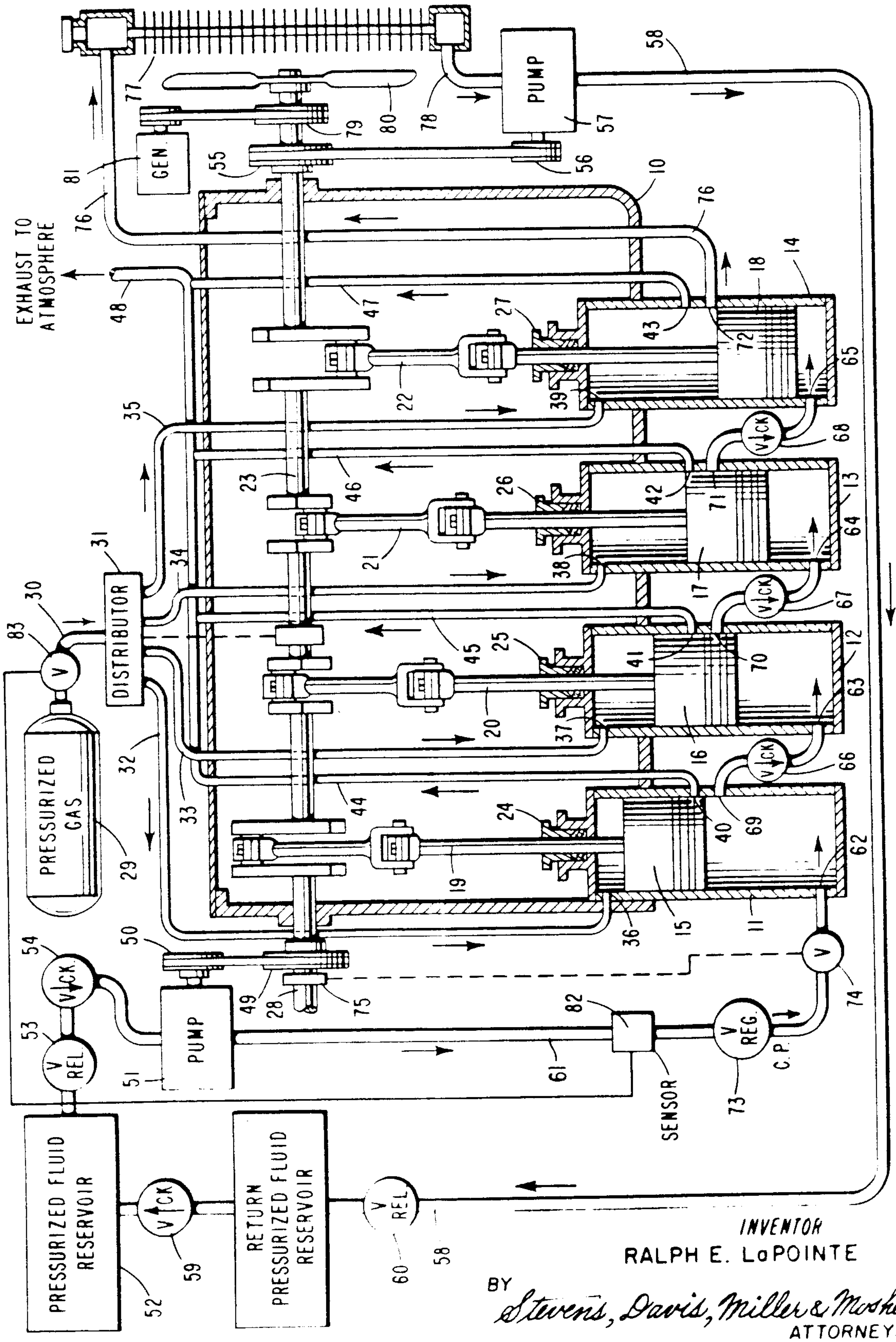
180—65; 290—16, 17; 318—138

Non-self-fueling air car with hydraulic transmission

Feb. 16, 1971 R. E. LA POINTE **3,563,032**

HYDROSTATIC PRESSURE PRIME MOVER

Filed March 27, 1970



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HYDROSTATIC PRESSURE PRIME MOVER

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Continuation-in-part of application Ser. No. 719,498, Apr. 8, 1968. This application Mar. 27, 1970, Ser. No. 23,411

Int. Cl. F01b *21/02*

U.S. Cl. 60—49 10 Claims

ABSTRACT OF THE DISCLOSURE

A hydrostatic pressure operated prime mover having a block in which a conventional crankshaft is turned in response to the reciprocating displacement of a plurality of pistons in a like plurality of cylinder chambers, the pistons being subjected to the sequential action of two separate pressurizing fluids acting on opposite end faces of the pistons. One pressurized fluid is delivered sequentially to the cylinders from a first pressurized source and the resulting crankshaft rotation operates pump means to circulate the second pressurizing fluid. Since there is no combustion involved in operating this prime mover, pollution of the atmosphere is avoided.

The present application is a continuation-in-part of my application Ser. No. 719,498, filed Apr. 8, 1968, and now abandoned.

BACKGROUND OF THE INVENTION

A great need exists for a prime mover which can be used to operate automotive vehicles and the like at the required speeds without the combustion of fuel and the resulting pollution of the atmosphere. Various attempts have been made in the prior art to achieve this aim but without the desired amount of success. The object of the present invention is to provide a hydrostatic pressure operated power plant or prime mover which is entirely free from the combustion of fuels and therefore completely eliminates the atmospheric pollution which is inherently present in conventional internal combustion engines, while at the same time furnishing a practical device.

SUMMARY OF THE INVENTION

In the inventive prime mover, a first pressurized working fluid is delivered from a first pressure source through a distribution device to the respective ends of the pistons in the cylinder chambers to cause initial crankshaft rotation. The resulting initial piston displacement will vent the first working fluid to the atmosphere and the distribution device will cut off delivery of such fluid. The initial displacement and crankshaft rotation will also drive pressurizing pump means for a second working fluid, also under pressure, and which is now delivered to the opposite ends or working faces of the pistons to displace them in the opposite direction for causing further crankshaft rotation and the sequential delivery of further charges of the first working fluid to the cylinder chambers.

BRIEF DESCRIPTION OF THE DRAWINGS

The means for accomplishing the foregoing objects and other advantages, which will be apparent to those skilled in the art, are set forth in the following specification and claims and are illustrated in the accompanying drawing dealing with a basic embodiment of the present invention. Reference is made now to the drawing in which:

The single figure represents a diagrammatic cross sectional view through a prime mover embodying the invention.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, the cylinder block **10** has therein a plurality of cylinder chambers **11**, **12**, **13** and **14** within which are slidably mounted pistons **15**, **16**, **17** and **18**, respectively. Of course, any number of cylinders may be used as necessary. Only four have been shown for the sake of clarity of the drawings. The pistons are each connected by conventional connecting rod means **19**, **20**, **21** and **22** with a conventional crankshaft **23** having individual crank sections for each piston as shown. The connecting rods also pass through sealing means **24**, **25**, **26** and **27** at the upper end of each of the cylinder chambers. The crankshaft **23** is suitably journalled in the block for rotation and includes a power takeoff extension **28** outside of the cylinder block **10** and leading to the transmission.

A first pressurized working fluid, preferably nitrogen gas under high pressure, is contained in the remote, rechargeable pressurized source tank **29** (for example, a cylinder with a 220 cubic feet, 2000 p.s.i. capacity) having a feed line **30** leading to a rotary distribution device **31** having outlets adapted to register at certain times with feed lines **32**, **33**, **34** and **35** which in turn are connected to corresponding inlet ports **36** to **39** at the upper ends of cylinders **11**, **12**, **13** and **14**, respectively. The lines **32** to **35** are secured to the block **10** and the rotary distribution device **31** controls the emission of high pressure nitrogen to the cylinders **11** to **14** in the proper order and timing.

The rotary distribution device **31** is similar to the distributor of an internal combustion engine but feeds fluids rather than electricity. The device is driven from the crankshaft by conventional means, here noted by a dashed line.

The cylinders **11** to **14** have exhaust ports **40** to **43**, respectively, located close to the center position of the cylinders but on that side of the center towards the end having inlet ports **36** to **39** with the feed lines **32** to **35** connected therein. These ports connect with the exhaust lines **44** to **48** and vent to the atmosphere outside the block **10** as indicated at **48**. When the pistons **15** to **18** are in their uppermost position in the drawing, the exhaust ports **40** to **43** will be closed off by the respective pistons so that the pressurized gas entering the upper portion of the cylinder chamber will drive the pistons downwardly, in the proper order, to cause the initial crankshaft rotation and piston displacement. As each piston is thus displaced, the exhaust ports **40** to **43** will be sequentially uncovered by the pistons and the high pressure working gas above the pistons will be exhausted to atmosphere. Rotation of the distribution device **31** times the admission of high pressure nitrogen to the top of the next suceeding cylinder until all of the pistons have been sequentially forced downwardly a predetermined amount and have been vented to atmosphere, in proper order, as described.

This initial portion of the working cycle, caused by the first pressurized fluid from the tank **29**, causes rotation of the crankshaft **23** to drive the distribution device **31** by conventional means, as mentioned above. It also causes rotation of a first pulley **49** to drive a second pulley **50** on a first hydrostatic pressurizing pump **51** for a second working fluid, such as lightweight oil (preferably No. 5 oil), which is stored in a remote, inter-rechargeable pressurized feed reservoir **52** (for example, a cylinder with a 220 cubic feet, 2000 p.s.i. capacity). Suitable excess pressure relief and check valves **53** and **54**, respectively, are arranged between the pump **51** and the reservoir **52**. The initial crankshaft rotation also turns third pulley **55** near

its other end driving still a fourth pulley **56** connected with and driving a second hydrostatic pump **47**, feeding a return line **58** leading back to the reservoir **52**. There is a one way check valve **59** between the reservoir **52** and the pump **57** and an excess pressure relief valve **60** in the return line **58**.

The first pump **51** is capable of delivering the second working fluid under the required pressure through the line or pipe **61** into inlet ports **62** to **65** at the opposite or bottom end portions of the cylinders **11** to **14** in series as shown. One way check valves **66** to **68** are interposed between exhaust ports **69** to **71** of adjacent cylinders to prevent equalization of the pressures which would render the system inoperative if this occurred. Exhaust port **72** will be discussed later. A suitable pressure regulator **73** is provided in the line **61** in advance of the cylinders as well as a quick opening valve **74** operated by a device **75** on the crankshaft which responds to four positions of the pistons during rotation of the crankshaft. By this means, the second working fluid is delivered at the proper time sequence to the bottom portion of each cylinder **11** to **14**. After the first working fluid above the respective pistons has been exhausted, the second working fluid, such as oil, drives the pistons upwardly and imparts further rotation to the crankshaft **23** during the second portion of the working cycle of each cylinder. Upon leaving exhaust port **72** in the last cylinder **14**, the second working fluid flows through a return line **76** to cooling radiator **77** and line **78** to the second or return pump **53**.

Another pulley means **79** on the crankshaft drives the cooling fan **80** and other accessories, such as the generator **81**, to power electrical components of the vehicle. In the above manner, a continuous and properly timed operating cycle takes place repeatedly under the influence of the two separate and coordinated working fluid systems.

The hydrostatic pumps **51** and **57** can produce, e.g., 1500 p.s.i. per minute, and can be said to disengage at, e.g., 2000 p.s.i. and re-engage at e.g., 1000 p.s.i. The pressure regulator valves are of a high-low cutout type and are used to determine pressure tolerances. In the event of malfunctioning, the pressure relief valves set at, for example, 2500 p.s.i., will protect the system. The pressure regulator valve **73** on the incoming hydrostatic line (calibrated at e.g., 850 p.s.i.) will provide enough force to drive the pistons upward from the bottom of the cylinders. The nitrogen pressure will cut off when hydrostatic pressure is supplying the necessary energy to drive the pistons and cut in when additional energy is needed. This is accomplished by means of the pressure sensor **82** located in pipe **61** and valve **83** which is operatively connected to be responsive to the sensor.

It may be helpful to here summarize the flow paths of the two fluids. The first working fluid passes from tank **29** and valve **83** via pipe **30** to the distribution means **31** where it is sequentially directed to feed lines **32** to **35**. Since the flow of the first fluid is the same for each cylinder, only cylinder **11** will be described. The pressurized fluid enters port **36** and acts against the upper face of piston **15** to drive it downward until exhaust port **40** is uncovered. At this time the pressurized first fluid will be exhausted to atmosphere through exhaust line **44** and port **48**. The distribution device **31** has cut off flow of the first fluid to cylinder **11** by the time exhaust port **40** is opened.

The second fluid flows from reservoir **52** through valves **53** and **54** to pump **51**. From there it passes through pipe **61**, pressure sensor **82** and valves **73** and **74** to the cylinders. The second fluid begins a somewhat tortuous path through inlet **62**, exhaust port **69**, check valve **66**, inlet **63**, exhaust port **70**, check valve **67**, inlet **64**, exhaust port **71**, check valve **68**, inlet **65**, and exhaust port **72** before starting its return journey through return line **76**, radiator **77**, line **78**, pump **57**, return line **58** and valves **60** and **59** to reservoir **52**.

The rotary distribution device **31**, in effect, is the timing means of the first fluid or nitrogen system which acts on one side of the pistons whereas the valve means **74** is the timing means for the second working fluid controlling the admission of the same to the cylinders on the opposite side of each piston from the first fluid.

In view of the foregoing description, the operation of the inventive prime mover should now be clear. The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. It is to be understood that the form of the invention herewith shown and described is to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than the foregoing description. The various changes in shape, size and arrangement of the parts which may come within the meaning and range of equivalency of the claims are therefore to be embraced therein.

What is claimed is:

1. A prime mover comprising a crankshaft including a power take-off extension, a plurality of pistons drivingly connected to the crankshaft and having opposing first and second working faces, a like plurality of cylinders receiving the pistons therein and each having first inlet and first exhaust opening means, said first inlet means being located adjacent one end of said cylinders, said first exhaust opening means being located near the center of said cylinders, a source of first working fluid, means for delivering said first working fluid under pressure and in timed sequence to said first inlet opening means to act upon said first working faces to thereby drive the pistons in one direction in proper sequence, each said cylinder also having second inlet and second exhaust opening means, said second inlet means being at the opposite ends of said cylinders, said second exhaust means being near the center of said cylinders, a source of second working fluid, means to feed said second working fluid sequentially to said second inlet means to act upon said second working faces to drive the pistons in the opposite direction, pressurizing and circulating pump means for the second working fluid, and means drivingly connecting the crankshaft and said pressurizing and circulating pump means.

2. A prime mover as defined in claim **1**, wherein the pressurizing and circulating pump means comprises a pair of pumps, one upstream of the cylinders and one downstream thereof, cooling means for the second working fluid between the cylinders and the pump downstream of the cylinders.

3. A prime mover as defined in claim **1** further comprising check valve means in the delivery means for the second working fluid between the second exhaust means and second inlet means of each pair of cylinders to prevent equalization of the pressure of the second working fluid in adjacent cylinders.

4. A prime mover as defined in claim **1**, wherein the pressurizing and circulating pump means further comprises a feed line leading from one pump to the second inlet means of a first cylinder of the prime mover and then in series to all of the other cylinders and then to a second pump which returns the second working fluid to its source.

5. A prime mover as defined in claim **2**, wherein the means drivingly connecting the drive shaft and said pressurizing and circulating pump means comprises a pair of transmission means drivingly interconnecting the crankshaft and a pair of pumps whereby the latter are operated in unison.

6. A prime mover as defined in claim **5** wherein each transmission means comprises a pulley on the crankshaft, another pulley on an input shaft of one of said pumps, and means drivingly interconnecting said pulleys.

7. A prime mover as defined in claim **1** wherein the means for delivering said first working fluid comprises a rotary distributor device for controlling the feeding of the first working fluid to the cylinders in proper order

and timing, and transmission means drivingly interconnecting the crankshaft and distributor device.

8. A prime mover as defined in claim 7, further comprising a main feed line for the first working fluid connecting said source to the distributor device and branch feed lines connecting each of the cylinders to the distributor device and exhaust lines connecting each cylinder to atmosphere.

9. A prime mover as defined in claim 1, wherein the means for delivering said first working fluid comprises a high pressure source of said first working fluid remote from the cylinders.

10. A prime mover as defined in claim 1, wherein the pressurizing and circulating pump means for the second working fluid comprises a pair of pumps one upstream from the cylinders and one downstream therefrom, feed

line means running from the upstream pump sequentially through the cylinders to the downstream pump, reservoir means for the second working fluid, return line means connecting the downstream pump to said reservoir, and means connecting the reservoir to said upstream pump thus forming a closed fluid circuit.

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EDGAR W. GEOGHEGAN, Primary Examiner

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,563,032 60 Dated February 16, 1971

Inventor(s) Ralph E. La Pointe

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 29, "53" should read -- 57 --.

Signed and sealed this 4th day of April 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

United States Patent

Hudspeth et al.

[15] **3,666,038**

[45] **May 30, 1972**

[54] AIR PULSING SYSTEM

[72] Inventors: **Steve A. Hudspeth; John B. Lunsford,** both of Springfield, Oreg.

[73] Assignee: **FMA, Inc.,** Eugene, Oreg.

[22] Filed: **Oct. 8, 1970**

[21] Appl. No.: **79,124**

[52] **U.S. Cl.** ....**180/66 B,** 60/57 R, 60/62, 417/231

[51] **Int. Cl.** **B60k 3/00,** B60k 27/00

[58] **Field of Search** ....180/66 B, 66 R; 60/62, 57 R, 60/57 T, 6; 417/231, 233

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Primary Examiner—Benjamin Hersh
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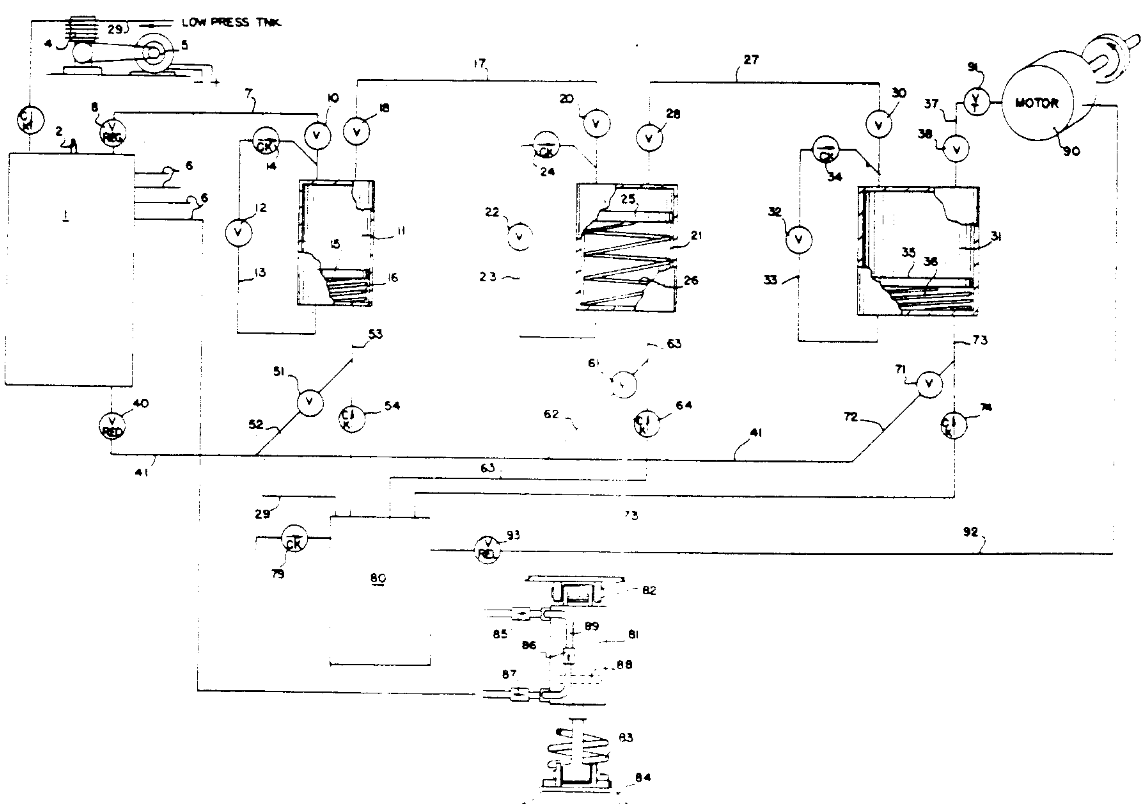
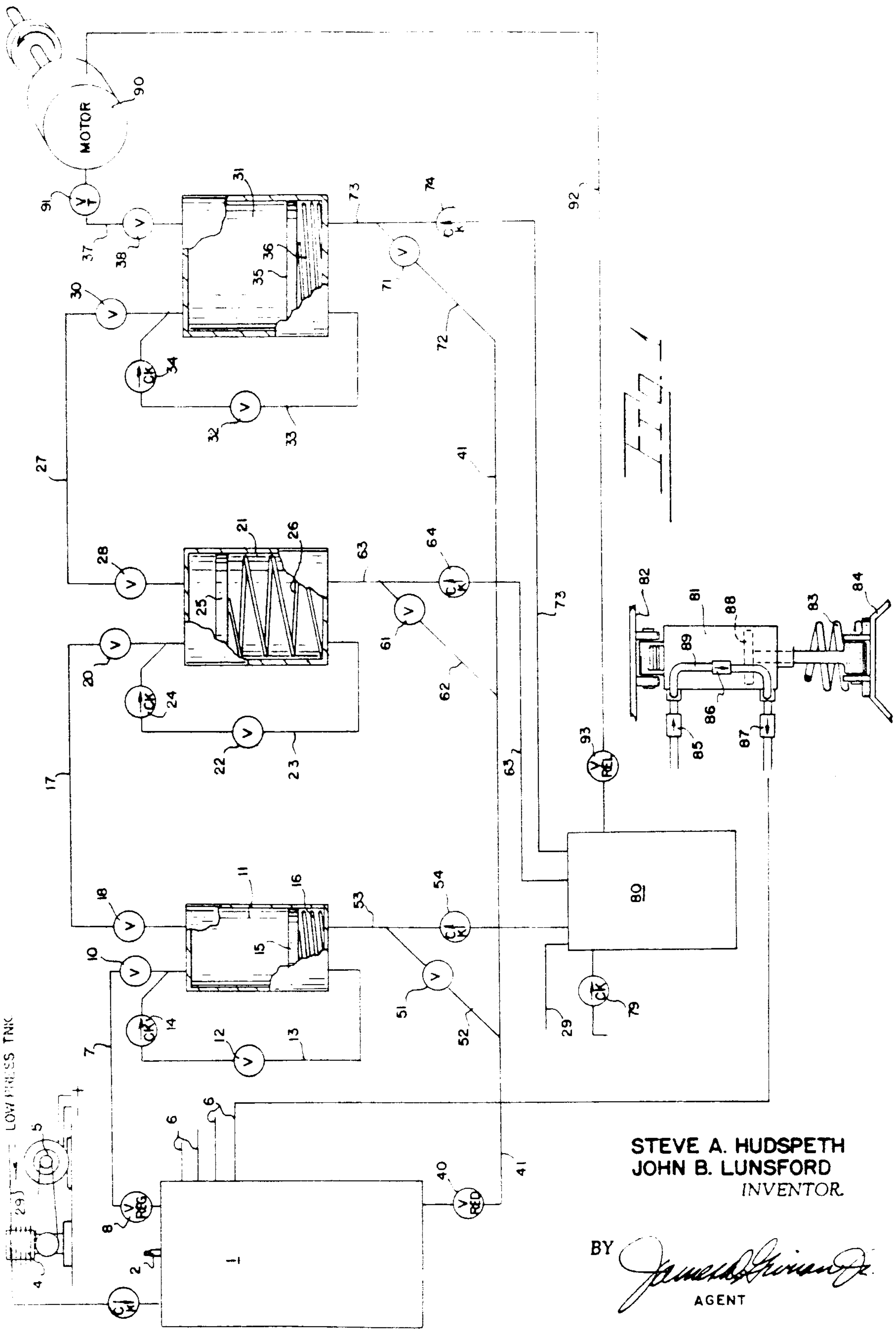
[57] **ABSTRACT**

A system utilizing a pressure storage vessel for initially charging a first air cylinder of a series of air cylinders. Valve means admits a flow of pressurized air, in a sequential manner, into the cylinders for piston movement downwardly to compress spring members to a loaded condition. Additional valve means, closed during downward piston movement, are subsequently actuated to permit discharge of an air impulse, by the action of said spring combined with a second source of air pressure acting on the underside of the piston. The last cylinder of the series is operable to impart a force to a media for the operation of a motor for powering a vehicle.

7 Claims, 3 Drawing Figures



Patented May 30, 1972 3,666,038



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Patented May 30, 1972

3,666,038

2 Sheets-Sheet 2

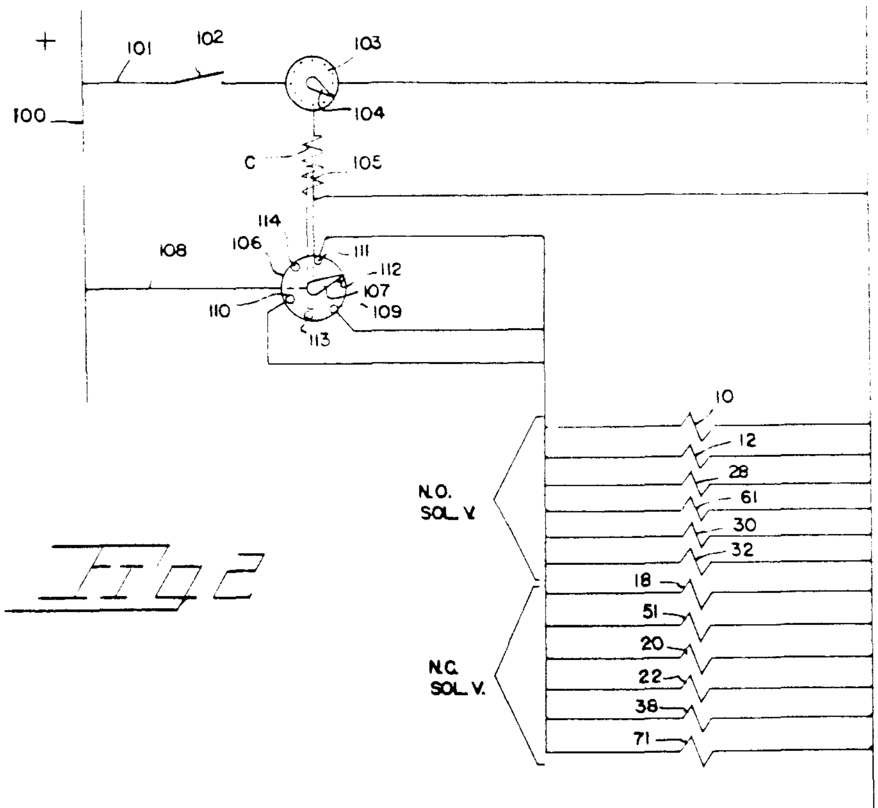

FIG. 2

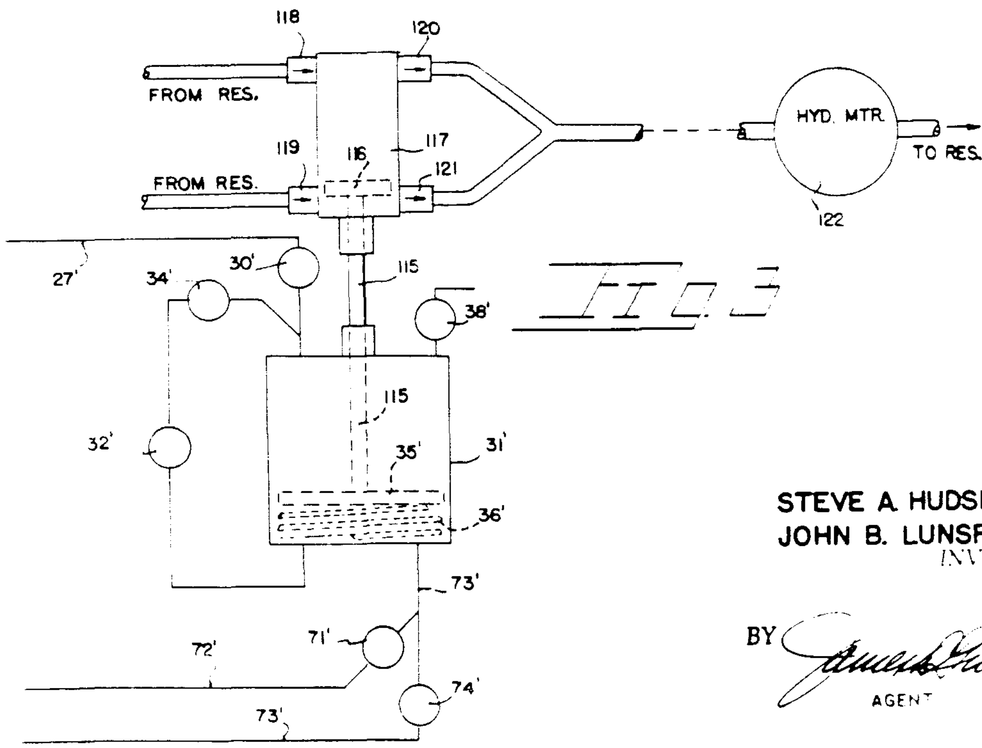

FIG. 3

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AIR PULSING SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates generally to a system for converting a pressurized air flow into a pulsating air flow wherein the air impulses are utilized to impart movement to a motor for powering of a vehicle.

The use of air as a media for imparting a driving force to the power train of a vehicle has, to a large extent, not proved practical. Further, the use of fluid powered motors associated in direct drive with a vehicles wheels also has apparently not proved practical for one reason or another. In such embodiments, fluid as a media for transmitting power is pressurized to provide a constant pressure flow through fluid motors associated with the vehicle wheels. The pumps in such arrangements are powered by the vehicles internal combustion engines.

SUMMARY OF THE INVENTION

The present invention is embodied in a series of cylinders with each cylinder having both a piston reciprocal therein responsive to differential pressures and resilient means acting on its piston. Air flows sequentially through the cylinders and ultimately past an air motor for conversion of the air flow to mechanical power. Air conduits in communication with each cylinder direct an air flow alternately to opposite sides of the piston therein with the air being forcefully discharged from each cylinder by the combined action of air pressure and the resilient member associated with the cylinder. Downstream of the motor is a low pressure tank constituting a source of low pressure air. Low pressure air is utilized to assist the resilient member of each cylinder to forcefully exhaust the air from the cylinder.

A high pressure tank provides an initial flow of high pressure air to the first cylinder of the series of cylinders. The tank may be of the type intermittently charged by compressor means or a storage tank capable of receiving periodic charges of air or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing:

FIG. 1 is a schematic of the air pulsing system,

FIG. 2 is a wiring schematic, and

FIG. 3 is a schematic of a portion of the pulsing system showing a modification thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With continuing reference to the drawings in which applied reference numerals indicate parts similarly identified in the following specification, the reference numeral **1** indicates a pressure storage vessel, charged with air in the present embodiment and for present purposes is termed a high pressure tank and may include conventional accumulator means.

For charging of the tank from an external air source, the tank is fitted with a valve at **2**. While the term air is used it will be understood that other medias such as hydraulic fluid may be used within the scope of the invention. An additional source of pressurized air for tank **1** is in the form of a compressor at **4** powered by an electric motor **5**. Constituting another or alternative source of air under pressure are tank supply lines at **6** each in communication at their unseen ends with air cylinders. The air cylinders are disposed adjacent each wheel of the vehicle for powering by travel of the wheel suspension member in relation to the vehicle frame and are, in combination with additional elements, the subject of a co-pending patent application, serial No. 97,125 filed Oct. 8, 1970, and entitled Vehicular Air Compression System. The tank **1** of the present system may be pressurized by one or more of the means above described. Details of the air cylinder are later described.

Exiting from tank **1** is a high pressure conduit **7** with a pressure regulator **8** therein. In one embodiment of the invention a line pressure of 80 PSI is provided to a first solenoid operated inlet valve **10** controlling the entry of air into a first air cylinder **11** of a series of air cylinders including cylinders at **21** and **31** each of increasing volume. Corresponding to valve **10** for controlling air to those other air cylinders are solenoid operated inlet valves **20** and **30** while similar valves at **12**, **22** and **32** hereinafter referred to as transfer valves control the air flow intermediate the ends of each cylinder. These latter valves are located in transfer lines **13**, **23**, **33** communicating the opposite ends of each cylinder with check valves at **14**, **24** and **34** for unidirectional air flow as indicated. Valves **10**, **12** and **30**, **32** are normally (deenergized) open in the present embodiment while valves **20**, **22** are normally closed.

Each cylinder includes a piston **15**, **25** and **35** biased by an internal compression loaded helical spring at **16**, **26** and **36** toward the high pressure inlet side of the cylinders. The springs **16**, **26** and **36** each have progressively greater spring rates for exerting a greater force on their respective pistons.

Exhaust conduits at **17**, **27** and **37** for the series of cylinders directs air past exhaust control valves respectively at **18**, **28** and **38** with exhaust conduits **17** and **27** being in communication with the solenoid operated inlet valves **20** and **30** serving the second and third air cylinders. Valves **18** and **38** are normally closed with valve **28** being of the normally open type.

What may be termed a low pressure air system provides that area below each of the pistons of each cylinder with a source of air under 10 PSI (above atmospheric) for actuation of their piston in the direction of spring biased movement. A low pressure regulator **40**, in a conduit **41**, reduces downstream pressure in conduit **41** to approximately the 10 PSI. Indicated at **51**, **61** and **71** are solenoid operated valves in lines **52**, **62** and **72** all branching off from conduit **41**. Valves **51** and **71** are of the normally closed type while valve **61** is normally open.

Additionally included in the low pressure system is a low pressure storage tank **80** constituting a second source of low pressure air for the cylinders **11**, **21** and **31**. A check valve at **79** admits air to tank **80** when less than atmospheric pressure is in the tank. Air exits tank **80** via lines **53**, **63** and **73** past check valves **54**, **64** and **74** with said lines incorporating Y connections to receive lines **52**, **62** and **72**. The check valves **54**, **64** and **74** are of the conventional spring biased type with the closing action of their springs offset in a combined manner by the negative upstream pressure during a merging air flow from line **52** into line **53**. An air line **29** is advantageously used to provide a source of low pressure air from tank **80** to compressor **4**.

Served by exhaust conduit **37** is an air motor **90** to which a pulsating flow of air is provided past a regulating valve **91**. The motor **90** may be of a conventional type such as a sliding vane type. A flywheel at **92** may be utilized to modify the effect of the irregular air impulses on the rotational speed of the motor shaft.

It will be apparent that the motor **90** may be fed by a second series of like cylinders, if desired, to provide air impulses at a greater frequency to said motor.

With reference to the wiring schematic of FIG. **2** one side of an electrical source is indicated at **100**, a first circuit includes lead **101** with an off-on master control switch **102** therein closeable to energize a timer **103** with a rotor arm **104** for closing a second circuit at desired intervals to a coil C actuating the armature **105** of a stepping switch **106**. Stepping switch **106** and its switch arm at **107** are operated by armature **105** to close circuits in alternate positions for operation of the solenoid operated valves. Moveable switch arm **107** of the stepping switch, in circuit via a conductor **108** with the electrical source, moves into timed contact with the contacts at **109**, **110** and **111** to actuate said valves with alternate arm positions at **112**, **113**, and **114** opening the valve operating circuits to permit said valves to return to their normal position.

With a pulsing cycle starting with the valves in their normal (deenergized) positions air flows past valve **10** into the top end of cylinder **11** with air below the piston being ported past open valve **12** and check **14** for convergence with the incoming air.

Simultaneously for the second cylinder **21**, normally closed valve **20** is closed as is valve **22** while normally open valves **28** permits a pulse of air to be exhausted from cylinder **21** by action of the spring biased piston **25** supplemented by spring **26** and an incoming air flow entering past open valve **61** and check **64**.

Simultaneously for the third cylinder **31**, normally open valve **30** admits the air impulse into the cylinders top end while air below the descending piston is transferred past normally open valve **32** and check **34** for mergence with the incoming flow of air. Normally closed valves **38** and **71** are closed at this time preparatory to the stepping switch energizing the solenoid valves at which time the condition of the valves is reversed to permit spring **36**, assisted by an incoming air flow, to forcefully travel to the upper end of cylinder **31** discharging an impulse of air to motor **90**.

For purposes of completeness of the present disclosure the wheel air cylinder is indicated at **81** and, as aforesaid, is included in the subject matter of a second U.S. patent application filed by the present inventors. The cylinder **81** is attached at its upper end to a vehicle frame member **82** and oppositely the cylinders piston rod end **83** is connected to a wheel suspension member **84** of a vehicle. Check valves at **85**, **86** and **87** permit a flow of air as indicated into the upper end of cylinder **81** from whence it is expelled by the upward stroke of piston **88**. A transfer conduit at **89** directs said flow to the rod side of the rising piston **88** during raising movement of the suspension member **84**. Subsequent opposite movement of the suspension member **84** as urged by the vehicle suspension spring **92** causes piston **88** to exhaust air therebelow past check **87** to tank **1**.

A modified form of the invention is disclosed in FIG. **3** wherein the third cylinder of the above described form of the invention is replaced by a cylinder **31'**. Valves at **30'**, **32'**, **38'**, **71'**, and **74'** in air lines **27'**, **72'** and **73'** all function in accordance with the first described form of the invention. A departure exists in that the piston **35'** urged by spring **36'** is provided with a piston rod **115**. The rod **115** terminates upwardly in a second piston **116**, the latter being the piston of a double acting hydraulic pump at **117**. An incoming flow enters alternately through check valves **118–119** while fluid is alternately exhausted, under pressure, past check valves **120–121** to a hydraulic motor **122**. It is to be understood that the hydraulic circuit would include the normal components of any hydraulic circuit, e.g., pressure relief and flow control valves, etc.,.

Motors **90**, and **122** of the modified form, may drive through suitable transmission and drive train components well known to those skilled in the present art.

While we have shown but two embodiments of the invention it will be apparent to those skilled in the art that the invention may be embodied still otherwise without departing from the spirit and scope of the invention.

Having thus described the invention what we desire to secure under a Letters Patent is:

1. A system for converting air under constant pressure to a pulsating air flow wherein the air impulses at peak pressure are of a substantially greater pressure value than said constant pressure for driving of a motor, said system comprising,
   - a pressure storage vessel,
   - a series of air cylinders each of progressively greater volume adapted to receive an air charge in an alternating manner, piston means within each of said cylinders, compressible means associated with each of said pistons and actuated upon the downward stroke of its piston for the conservation of energy expended by the piston, an air transfer line extending intermediate the ends of each cylinder and a transfer valve in each of said lines,
   - a fluid operated motor driven by the last cylinder of the series,
   - high pressure conduits intercommunicating the upper ends of said cylinders to provide same with a source of pressurized air, the first cylinder of the series receiving air via a high pressure conduit from said storage vessel with the remaining cylinders of the series receiving air moving sequentially through said cylinders,
   - inlet valves in said conduits admitting air under pressure to the upper ends of the cylinders for downward displacement of their pistons,
   - exhaust valves also in said conduits permitting an exhaust of air from the upper ends of the cylinders during upward piston movement,
   - low pressure conduits in communication with the lower ends of said cylinders and in communication with a source of low pressure air,
   - valves in said low pressure conduits permitting a flow of low pressure air through said last mentioned conduits into the lower ends of the cylinders during upward travel of said pistons, and
   - a control circuit simultaneously opening the inlet valve and transfer valve associated with each cylinder for admitting a flow of high pressure air and air transferred from the bottom side of the cylinder, said control circuit simultaneously closing the exhaust valve and the low pressure valve associated with each cylinder during the downstroke of the piston, said circuit operable additionally to simultaneously reserve the positions of the valves whereby the piston under the influence of low pressure air and said compressible means causes an impulse of air to be exhausted into the high pressure conduit and to a subsequent cylinder of the series with the piston of the last cylinder of the series operable to impart a force to a media for the operation of a motor.

2. The system as claimed in claim **1** installed on a vehicle and additionally including wheel air cylinders disposed intermediate the frame and movable wheel suspension members of a vehicle, said air cylinders constituting an air pumping means for charging said pressure storage vessel.

3. The system as claimed in claim **1** wherein said transfer line of each piston and the high pressure conduit serving the piston merge whereby a combined flow of air and air exhausted from the lower end of the cylinder enter the upper end of the cylinder.

4. The system as claimed in claim **1** additionally including a low pressure tank to receive the air exhausted by said fluid operated motor, additional low pressure conduits communicating the low pressure tank with the lower end of said cylinders.

5. The system as claimed in claim **4** wherein each of said cylinders is supplied with a merging flow of low pressure air said additional low pressure conduits including check valves.

6. The system as claimed in claim **1** wherein said compressible means comprises a helical compression spring housed within each of said cylinders, said springs having a spring rate increasing proportionally to the diameter of the cylinders.

7. The system as claimed in claim **1** additionally including a low pressure tank in receiving communication with said fluid motor, said low pressure conduits including both conduits in communication with said last mentioned tank and the cylinders and additional conduits in communication with the pressure storage vessel via pressure reducing means whereby either said lower pressure tank or said vessel may supply low pressure air to the underside area of the pistons.

* * * * *

United States Patent [19] [11] 3,744,252
Van Valkinburgh [45] July 10, 1973

[54] CLOSED MOTIVE POWER SYSTEM UTILIZING COMPRESSED FLUIDS

[75] Inventor: Eber H. Van Valkinburgh, Reno, Nev.

[73] Assignee: Endless Power Corporation, Inc., Reno, Nev.

[22] Filed: Nov. 11, 1971

[21] Appl. No.: 197,667

[52] U.S. Cl. 60/468, 60/33
[51] Int. Cl. F03b 1/00, F15b 1/02
[58] Field of Search 60/51, 55, 54

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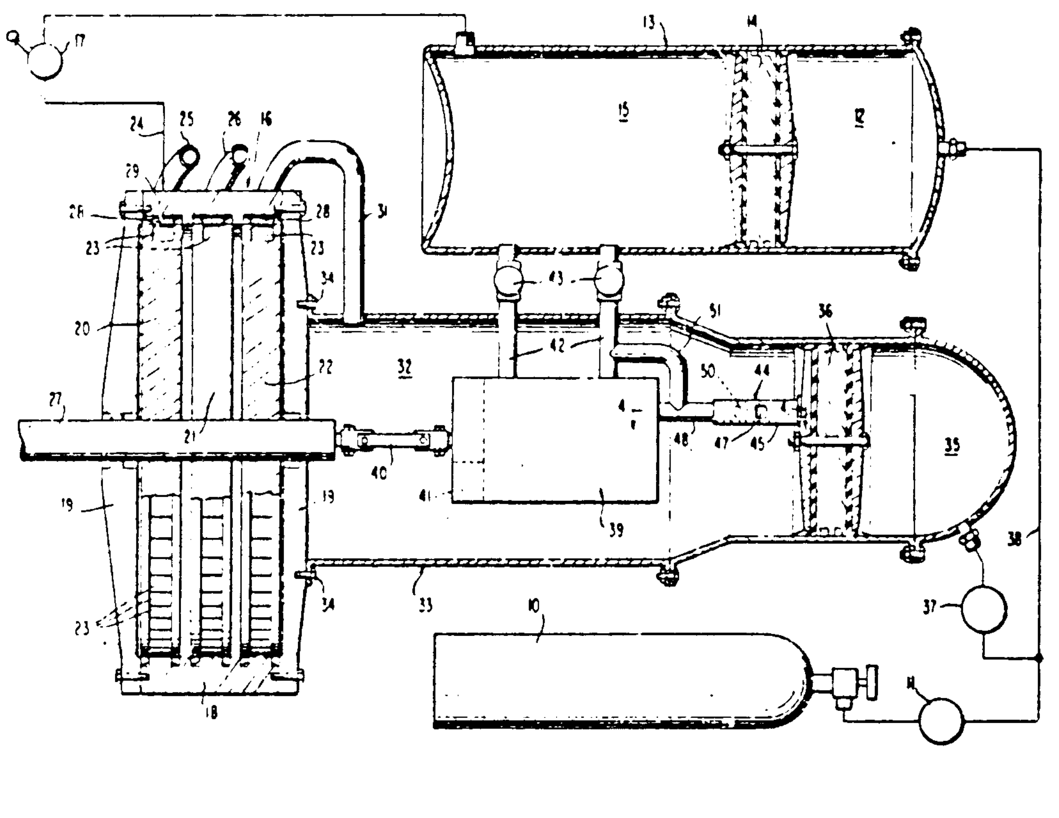
Primary Examiner—Edgar W. Geoghegan
Attorney—Rupert J. Brady et al.

[57] ABSTRACT

Stored energy in a compressed elastic fluid is utilized in a controlled manner to pressurize an inelastic fluid and to maintain such pressurization. The pressurized inelastic fluid is throttled to the impeller of a prime mover. A portion only of the output energy from the prime mover is utilized to operate a circulating means for the inelastic fluid so as to maintain a nearly constant volumetric balance in the system.

12 Claims, 5 Drawing Figures



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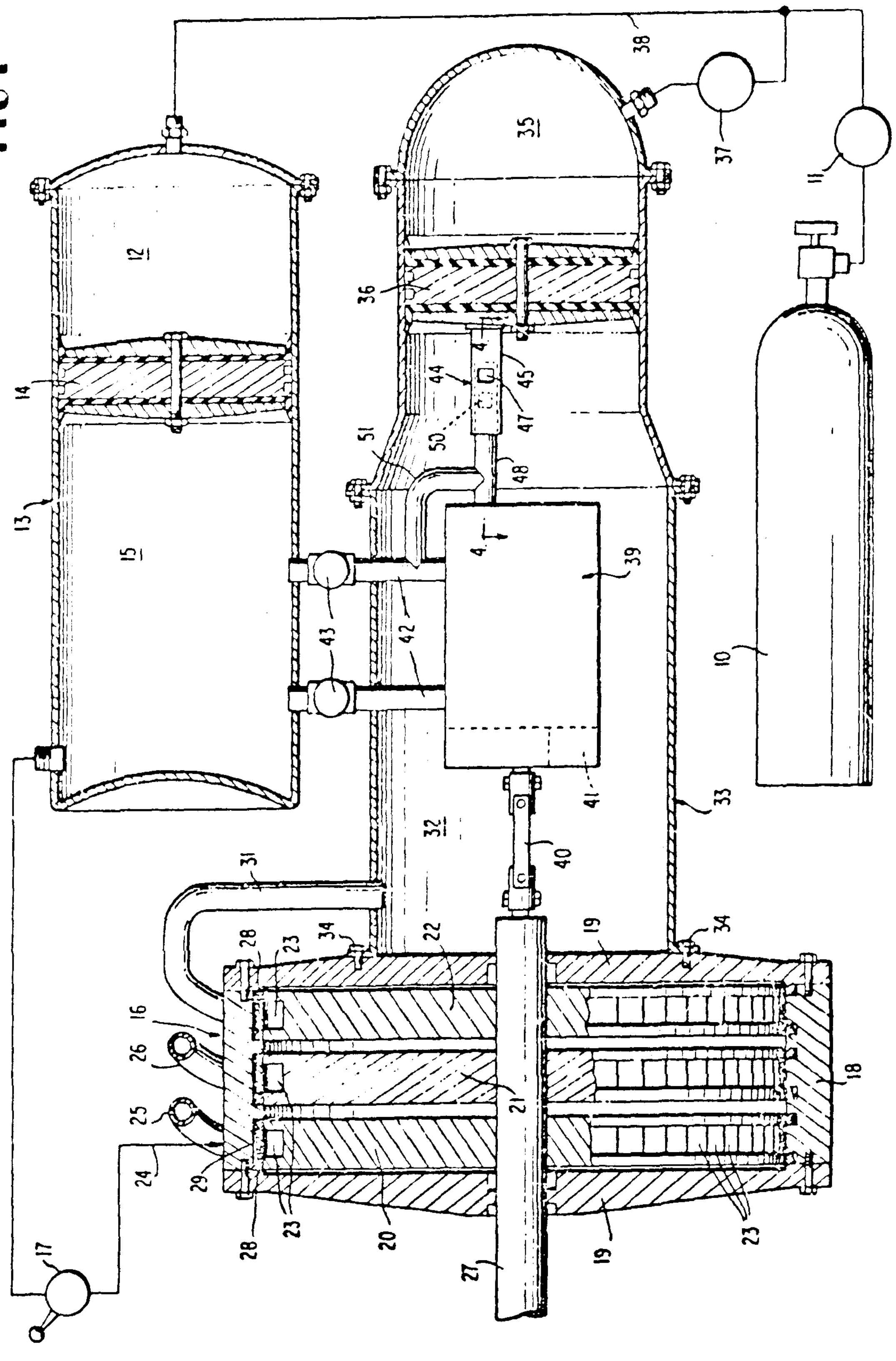
SHEET 1 OF 2

FIG I



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SHEET 2 OF 2

FIG. 2

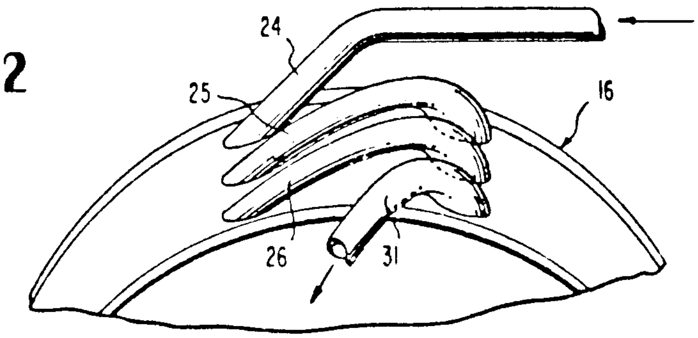


FIG. 3

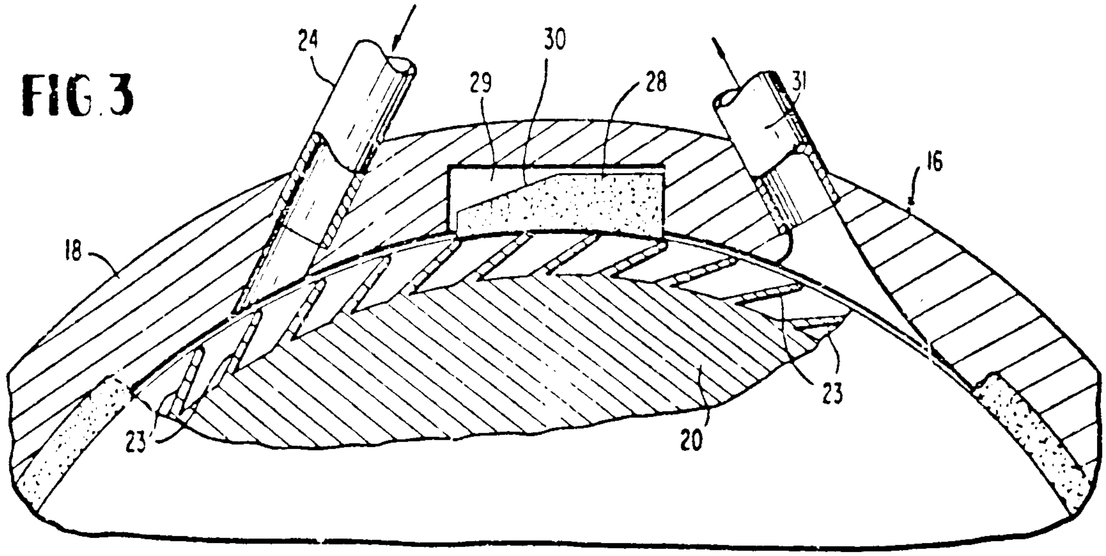


FIG. 4

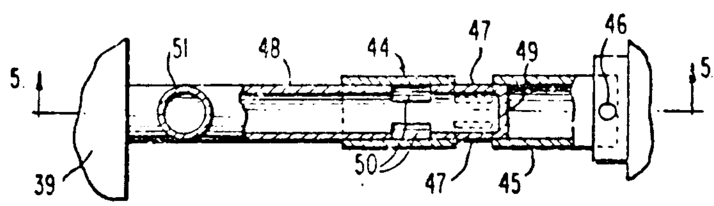
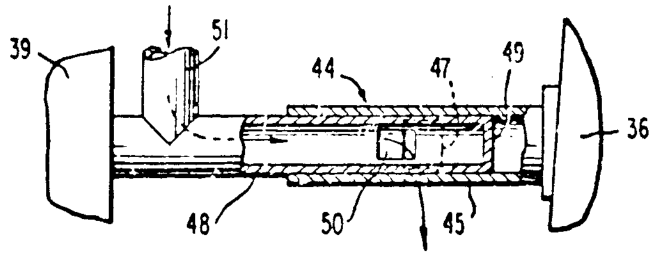


FIG. 5



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CLOSED MOTIVE POWER SYSTEM UTILIZING COMPRESSED FLUIDS

The objective of the invention is to provide a closed loop power system which utilizes the expansive energy of a compressed elastic fluid, such as air, to pressurize and maintain pressurized throughout the operational cycle of the system a second non-elastic and non-compressible fluid, such as oil. The pressurized non-elastic fluid is released in a controlled manner by a throttling means to the rotary impeller of a turbine or the like having a work output shaft. This shaft is coupled to a pump for the non-elastic fluid which maintains automatically the necessry circulation demanded by the operation of the prime mover, and also maintains a near volumetric balance in the system between the two fluids which are separated by self-adjusting free piston devices. The pump or circulating means for the non-elastic fluid includes an automatic by-pass for the non-elastic fluid which eliminates the possibility of starving the pump where the latter depends on the discharge of the non-elastic fluid at low pressure from the exhaust of the turbine.

Other features and advantages of the invention will become apparent during the course of the following detailed description.

BRIEF DESCRIPTION OF DRAWING FIGURES

FIG. 1 is a partly schematic cross sectional view of a closed motive power system embodying the invention.

FIG. 2 is a fragmentary perspective view of a rotary prime mover utilized in the system.

FIG. 3 is an enlarged fragmentary vertical section through the prime mover taken normal to its rotational axis.

FIG. 4 is an enlarged fragmentary vertical section taken on line 4—4 of FIG. 1.

FIG. 5 is a similar section taken on line 5—5 of FIG. 4.

DETAILED DESCRIPTION

Referring to the drawings in detail, wherein like numerals designate like parts throughout, the numeral 10 designates a supply bottle or tank for a compressed elastic fluid, such as air. Preferably, the air in the bottle 10 is compressed to approximately 1,500 p.s.i. The compressed air from the bottle 10 is delivered through a suitable pressure regulating valve 11 to the chamber 12 of a high pressure tank 13 on one side of a free piston 14 in the bore of such tank. The free piston 14 separates the chamber 12 for compressed air from a second chamber 15 for an inelastic fluid, such as oil, on the opposite side of the free piston. The free piston 14 is movable axially within the bore of the cylindrical tank 13 and is constantly self-adjusting therein to maintain a proper volumetric balance between the two separated fluids of the system. The free piston has the ability to maintain the two fluids, air and oil, completely separated during the operation of the system.

The regulator valve 11 delivers compressed air to the chamber 12 under a pressure of approximately 500 p.s.i. The working inelastic fluid, oil, which fills the chamber 15 of high pressure tank 13 is maintained under 500 p.s.i. pressure by the expansive force of the elastic compressed air in the chamber 12 on the piston 14.

The oil in the chamber 15 is delivered t[illegible] mover 16, such as an oil turbine, throug[illegible]

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supply regulating or throttle valve 17 which controls the volume of pressurized oil delivered to the prime mover.

The turbine 16 embodies a stator consisting of a cas- [illegible] ring 18 and end cover plates 19 joined thereto in a [illegible] manner. It further embodies a single or plural st[illegible]eller or rotor having bladed wheels 20, 21 and 22 [illegible] the illustrated embodiment. The peripheral blades 23 of these turbine wheels receive the motive fluid from the pressurized chamber 15 through serially connected nozzles 24, 25 and 26, connected generally tangentially through the stator ring 18, as shown in FIG. 3. The first nozzle 24 shown schematically in FIG. 1 is connected directly with the outlet of the throttle valve 17. The successive nozzles 25 and 26 deliver the pressurized working fluid serially to the blades 23 of the turbine wheels 21 and 22, all of the turbine wheels being suitably coupled to a central axial output or working shaft 27 of the turbine 16.

Fiber back pressure sealing blocks 28 are contained within recesses 29 of casing ring 18 to prevent comingling of the working fluid and exhaust at each stage of the turbine. A back pressure sealing block 28 is actually only required in the third stage between inlet 26 and exhaust 31, because of the pressure distribution, but such a block can be included in each stage as shown in FIG. 1. The top surface including a sloping face portion 30 on each block 28 reacts with the pressurized fluid to maintain the fiber block sealed with the adjacent bladed turbine wheel; and the longer the slope on the block to increase the top surface area thereof, the greater will be the sealing pressure against the periphery of the wheel.

Leading from the final stage of the turbine 16 is a low pressure working fluid exhaust nozzle 31 which delivers the working fluid, oil, into an oil supply chamber or reservoir 32 of a low pressure tank 33 which may be bolted to the adjacent end cover plate 19 of the turbine, as indicated at 34. The oil entering the reservoir chamber 32 from the exhaust stage of the turbine is at a pressure of about 3–5 p.s.i. In a second chamber 35 of the low pressure tank 33 separated from the chamber 32 by an automatically moving or self-adjusting free piston 36, compressed air at a balancing pressure of from 3–5 p.s.i. is maintained by a second pressure regulating valve 37. The pressure regulating valve 37 is connected with the compressed air supply line 38 which extends from the regulating valve 11 to the high pressure chamber 12 for compressed air.

Within the chamber 32 is a gear pump 39 or the like having its input shaft connected by a coupling 40 with the turbine shaft 27. Suitable reduction gearing 41 for the pump may be provided internally, as shown, or in any other conventional manner, to gear down the rotational speed derived from the turbine shaft. The pump 39 is supplied with the oil in the filled chamber 32 delivered by the exhaust nozzle or conduit 31 from the turbine. The pump, as illustrated, has twin outlet or delivery conduits 42 each having a back pressure check valve 43 connected therein and each delivering a like volume of pressurized oil back to the high pressure chamber 15 at a pressure of about 500 p.s.i. The pump 39 also has twin fluid inlets. The pump employed is preferably of the type known on the market as "Hydreco Tandem Gear Pump," Model No. 151515, L12BL, or equivalent. In some models, other types of pumps could be employed including pumps having a

single inlet and outlet. The illustrated pump will operate clockwise or counter-clockwise and will deliver 14.1 g.p.m. at 1,800 r.p.m. and 1,500 p.s.i. Therefore, in the present application of the pump 39, it will be operating at considerably less than capacity and will be under no strain.

Since the pump depends for its supply of fluid on the delivery of oil at low pressure from the turbine 16 into the chamber 32, an automatically operating by-pass sleeve valve device 44 for oil is provided as indicated in FIGS. 1, 4 and 5. This device comprises an exterior sleeve or tube 45 having one end directly rigidly secured as at 46 to the movable free piston 36. This sleeve 45 is provided with slots 47 intermediate its ends. A coacting interior sleeve 48 engages telescopically and slidably within the sleeve 45 and has a closed end wall 49 and ports or slots 50 intermediate its ends, as shown. The sleeve 48 communicates with one of the delivery conduits 42 by way of an elbow 51, and the sleeve 48 is also connected with the adjacent end of the pump 39, as shown.

As long as the chamber 32 is filled with low pressure oil sufficient to balance the low air pressure in the chamber 35 on the opposite side of free piston 36, such piston will be positioned as shown in FIGS. 1 and 4 so that the slots 47 and 50 of the two sleeves 45 and 48 are out of registration and therefore non-communicating. Under such circumstances, the oil from the chamber 32 will enter the pump and will be delivered by the two conduits 42 at the required pressure to the chamber 15. Should the supply of oil from the turbine 16 to the chamber 32 diminish so that pump 39 might not be adequately supplied, then the resulting drop in pressure in the chamber 32 will cause the free piston 36 to move to the left in FIG. 1 and bring the slots 47 into registration or partial registration with the slots 50, as depicted in FIG. 5. This will instantly establish a by-pass for oil from one conduit 42 back through the elbow 51 and tubes 48 and 45 and their registering slots to the oil chamber 32 to maintain this chamber filled and properly pressurized at all times. The by-pass arrangement is completely automatic and responds to a diminished supply of oil from the turbine into the chamber 32, so long as the required compressed air pressure of 3–5 p.s.i. is maintained in the chamber 35.

Briefly, in summary, the system operates as follows. The pressurized inelastic and non-compressible fluid, oil, from the chamber 15 is throttled into the turbine 16 by utilizing the throttle valve 17 in a control station. The resulting rotation of the shaft 27 produces the required mechanical energy or work to power a given instrumentality, such as a propeller. A relatively small component of this work energy is utilized through the coupling 40 to drive the pump 39 which maintains the necessary volumetric flow of oil from the turbine back into the high pressure chamber 15, with the automatic by-pass 44 coming into operation whenever needed.

The ultimate source of energy for the closed power system is the compressed elastic fluid, air, in the tank or bottle 10 which through the regulating valves 11 and 37 maintains a constant air pressure in the required degree in each of the chambers 12 and 35. As described, the air pressure in the high pressure chamber 12 will be approximately 500 p.s.i. and in the low pressure chamber 35 will be approximately 3–5 p.s.i.

It may be observed in FIG. 1 that the tank 33 is enlarged relative to the tank 13 to compensate for the space occupied by the pump and associated components. The usable volumes of the two tanks are approximately equal.

In an operative embodiment of the invention, the two free pistons 14 and 36 and the tank bores receiving them are 8 inches in diameter. The approximate diameters of the bladed turbine wheels are 18 inches. The pump 39 is approximately 10 inches long and 5 inches in diameter. The tank 13 is about 21 inches long between its crowned end walls. The tank 33 is 10 inches in diameter adjacent to the pump 39.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof but it is recognized that various modifications are possible within the scope of the invention claimed.

I claim:

1. A power system comprising a high pressure tank and a low pressure tank each having a bore, a free piston in the bore of each tank dividing each tank into separated chambers for elastic and non-elastic fluids, a source of pressurized elastic fluid, pressure regulating means interconnected between said source and said chambers of the tanks for elastic fluid so that elastic fluid at a relatively high pressure is delivered to the high pressure tank and elastic fluid at a relatively low pressure is delivered to the low pressure tank, a prime mover having a driven output member and a working fluid inlet and exhaust, said exhaust communicating with the chamber of the low pressure tank for non-elastic fluid, flow regulating means interconnecting said working fluid inlet and the chamber of said high pressure tank for non-elastic fluid, and a circulating means for said non-elastic fluid within the chamber of the low pressure tank for non-elastic fluid and coupled with said driven output member and operated thereby and having a connection with the chamber of the high pressure tank for non-elastic fluid and delivering such fluid to such chamber.

2. The structure of claim 1, and an automatic by-pass device for said non-elastic fluid connected with said circulating means and including a movable part connected with the free piston in the bore of the low pressure tank, whereby movement of the free piston in one direction responsive to a diminishing of the non-elastic fluid in the low pressure tank will activate the automatic by-pass device and return non-elastic fluid from the circulating means to the chamber of the low pressure tank for non-elastic fluid.

3. The structure of claim 1, and said source of pressurized elastic fluid comprising a closed container of compressed air.

4. The structure of claim 1, and said pressure regulating means comprising a pair of pressure regulating valves.

5. The structure of claim 1, and said prime mover comprising a turbine having a rotary impeller, said driven output member being a rotary shaft coupled with the impeller, said working fluid inlet delivering non-elastic fluid to the impeller from the high pressure tank.

6. The structure of claim 5, and said flow regulating means comprising an adjustable throttle valve.

7. The structure of claim 1, and said circulating means comprising a pump having an input drive mem-

ber connected with the driven output member of the prime mover.

8. The structure of claim 7, wherein said input drive member of the pump and said driven output member of the prime mover are rotary shafts, and means mechanically coupling said shafts.

9. The structure of claim 2, and said automatic by-pass device including a pair of telescopically interfitting sleeves having fluid flow slots adapted to assume registering and non-registering positions, one sleeve constituting said movable part connected with said free piston, whereby movement of the free piston in said one direction will move said slots into registration and thereby activate the by-pass device.

10. The structure of claim 5, and said turbine impel-

ler comprising a multiple stage bladed impeller, said working fluid inlet consisting of nozzles delivering said non-elastic fluid to the multiple stages of said impeller serially, and said exhaust delivering non-elastic fluid from the final stage of the impeller to said chamber of the low pressure tank for non-elastic fluid.

11. The structure of claim 8, wherein said pump is a twin outlet gear pump, each outlet of the pump connected with the chamber of the high pressure tank for non-elastic fluid, and a back pressure check valve connected in each pump outlet.

12. The structure of claim 11, and said automatic by-pass device having a connection with one outlet of said pump.

* * * * *

been patented by a Texan, 45. But his continual puttering in the basement cost him his wife's love as he perfected the wonder he'd dreamed of for 20 years ...

Trucker Invents Miracle Engine

By CLIFF LINEDECKER
Of the Tattler Staff

A truck driver whose basement experiments cost him his wife and $100,000 has developed an air-powered engine which could solve both the energy crisis and the air pollution dilemma.

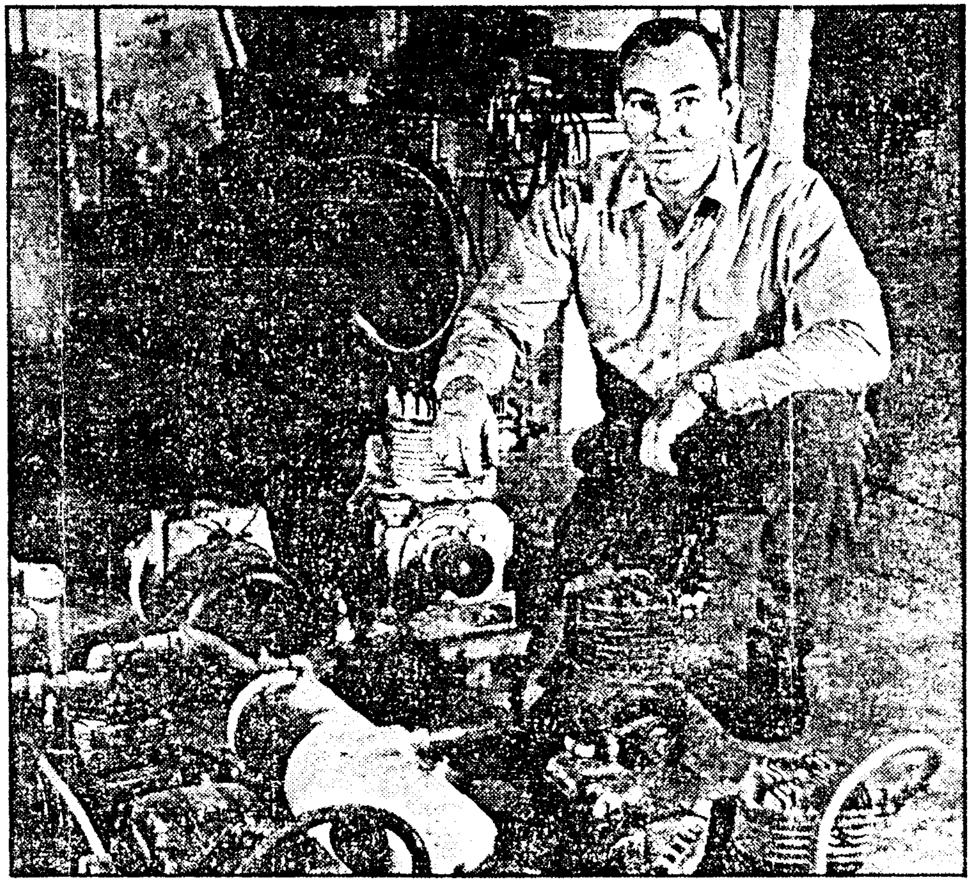
Russell R. Brown conceived the idea of a compressed air engine more than 20 years ago when he was trucking crude oil in Texas oil fields, but it took the laughter and jeers of fellow truckers to spur him to the discovery which could revolutionize the world.

The U.S. Patent Office recently granted the 45-year-old Texas native a patent on his invention. Not only does the engine run on air, but it can be constructed so that it creates its own source of power.

"My hope is to get a pilot plant set up," Brown told TATTLER. "This has opened an entirely new field and there's no limit to how far we can go.

"There's no fuel pump, no plugs, no carburetor and no exhaust system such as we know," Brown said in his Harrisburg, Pa., home. "It's capable of powering cars, trucks, ships, aircraft and myriad other uses not even thought of yet."

Inventor Brown in pensive mood.



RUSSELL R. BROWN displays the parts of an engine he built that runs on air alone.

The engine is simple, Brown said. An electric power source is switched on to run an air compressor. When pressure is sufficient, the compressed air pushes the pistons and the electrical power source is shut off. Even the air is recycled, Brown said.

"WE'RE PLAGUED with pollution, but my engine does no more damage to the air than if you inflate a tire and let it out again," the trucker-turned-inventor said. "It can revolutionize the whole world."

Brown pondered the air-powered engine for more than 20 years after he noticed steam pumps in Texas refineries.

"That's when I began to visualize my engine," Brown recalls, "but I never did anything about it and probably wouldn't have until those guys (other truckers) laughed at me when I talked about it.

"I said to the boys, 'If we can use 120 pounds of pressure to bring a truck going 70 miles an hour to a screeching halt, we can use air pressure to make it go'," Brown said. "They laughed at me."

He got the same response at home. "Even my kids used to say, 'Daddy's down in the basement playing'," Brown said.

"Now they're proud of me."

BUT THE BASEMENT experiments proved to be costly for Brown. He spent most of the money he had earned during his 30-year trucking career plus about $10,000 from friends who believed in him and his engine.

"And I'm $5,000 in debt right now," Brown said. "If I'd known the money I was going to spend in the last four years, I would never have started.

"In fact, there's no possible way I can say what it's going to cost yet," Brown said.

His dogged devotion to his revolutionary engine ultimately cost Brown his marriage. "My wife left me because I spent so much time working on the engine and she thought I must have been crazy," he said.

Meanwhile, his engine safely patented, Brown is weighing several lucrative offers. He already has rejected a $100,000 offer from a Harrisburg investment firm for a 25 per cent investment in his invention.

EVEN MORE recently, a businessman approached Brown with a "$5 or $10 million deal." "I'm getting inquiries from all over the world about working with me," Brown said. "If I can get the right backing, you will be seeing some of these engines pretty soon.

"I never invented anything else," he said, "but now I'm sitting and thinking things over. All kinds of ideas are going through my head."

But now no one's laughing.

United States Patent [19]

Brown

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[45] **Oct. 16, 1973**

[54] **COMPRESSED AIR ENGINE**

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[21] Appl. No.: **277,629**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 113,014, Feb. 5, 1971, abandoned.

[52] **U.S. Cl.** **60/370,** 60/374, 60/415, 91/4

[51] **Int. Cl.** **F15b 11/06,** F15b 3/00

[58] **Field of Search** .... 60/57 R, 62, 51, 60/370, 374, 415; 91/4

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Primary Examiner—Edgar W. Geoghegan
Attorney—Lawrence R. Radanovic

[57] **ABSTRACT**

Compressed air engine having an auxiliary air compressor for building up to a minimum a predetermined air pressure in a compressed air supply tank which feeds air through an engine RPM control valve for the engine pistons. Upon reaching the minimum air pressure, the electric motor is cut off and the auxiliary compressor is simultaneously engaged with the crankshaft to continue to build up to a maximum predetermined air pressure level and maintain this level for operation of the engine. A main recycle air compressor is provided for recycling. The multi-cylinder four-cycle combustion engine motor block may be converted into a four-cycle compressor for the system, and hydraulic means may also be used as a force-multiplying means for operation of the crankshaft.

9 Claims, 5 Drawing Figures

UNPOPULAR SCIENCE

1974 by Art Rosenblum

RISKS OF PSYCHIC RESEARCH: Last Saturday, I spent most of the day driving between Philadelphia and Harrisburg with an engineer in order to check on a claimed invention of another "fuelless engine" by a man named Russell Brown, which had received rather wide TV and newpaper coverage. We found Mr. Brown to be an honest person, but were able to determine that he did not actually have an invention that seemed likely to overcome the need for fuel as a motive power source. He seemed to lack the scientific background to accomplish the ideals which he has set for himself.

During the trip, we spoke about various psychic experiences and were reminded of the danger, which is very real, in the pursuit of knowledge of the spirit world, especially when such knowledge is sought for reasons other than a pure and sincere love for the creation and its purpose.

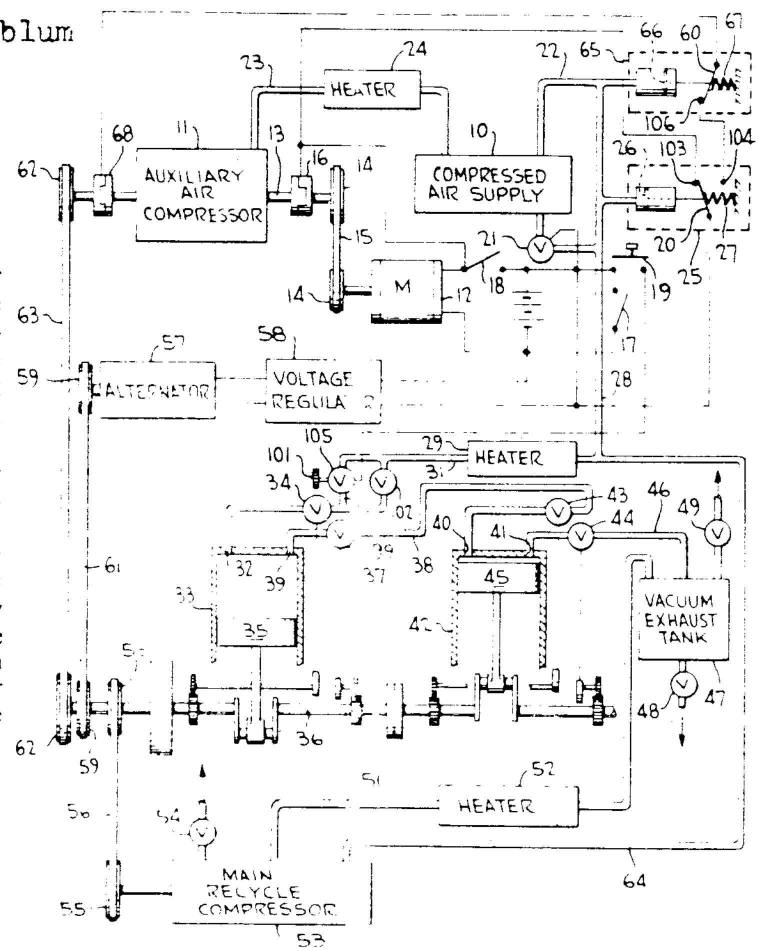

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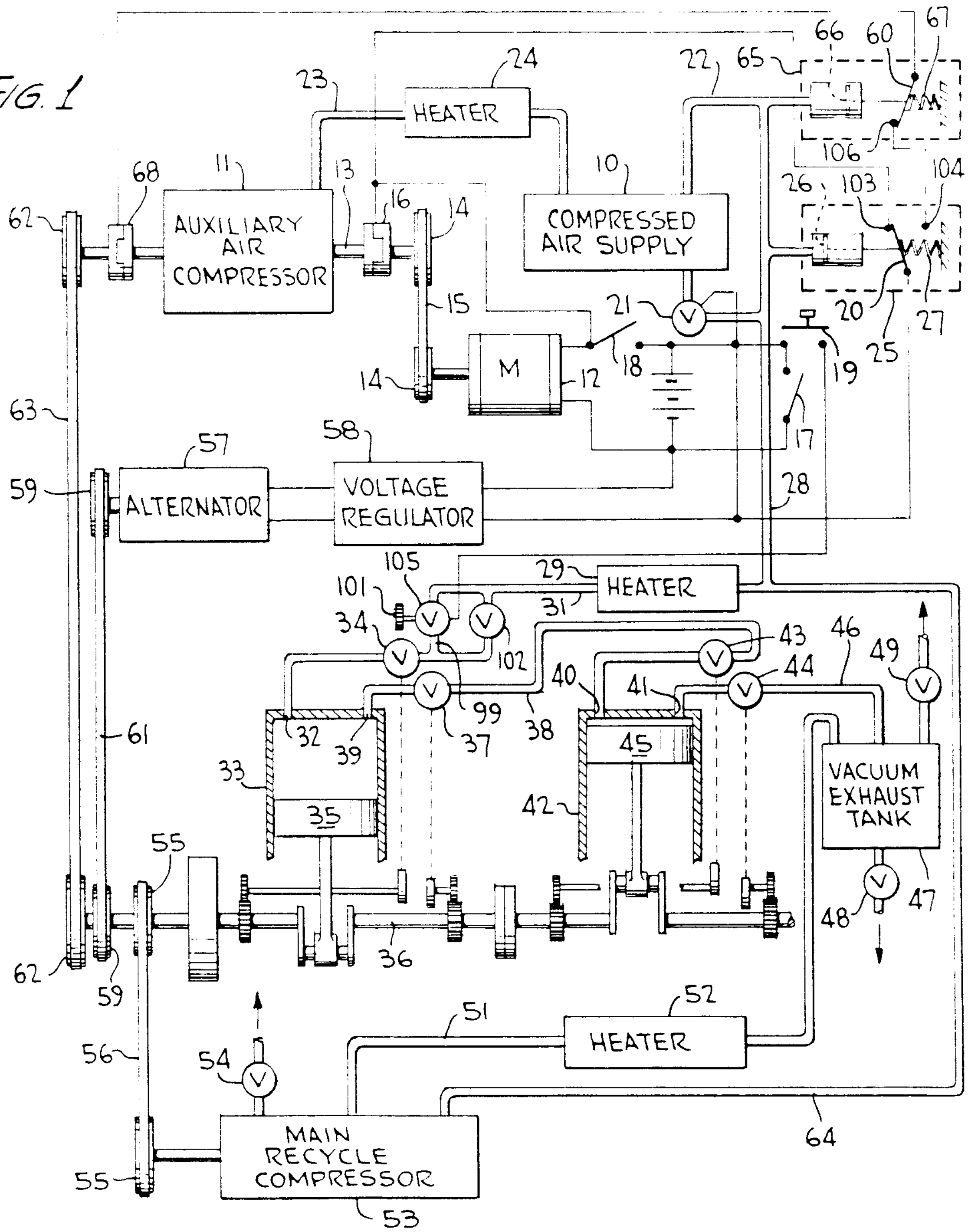
FIG. 1



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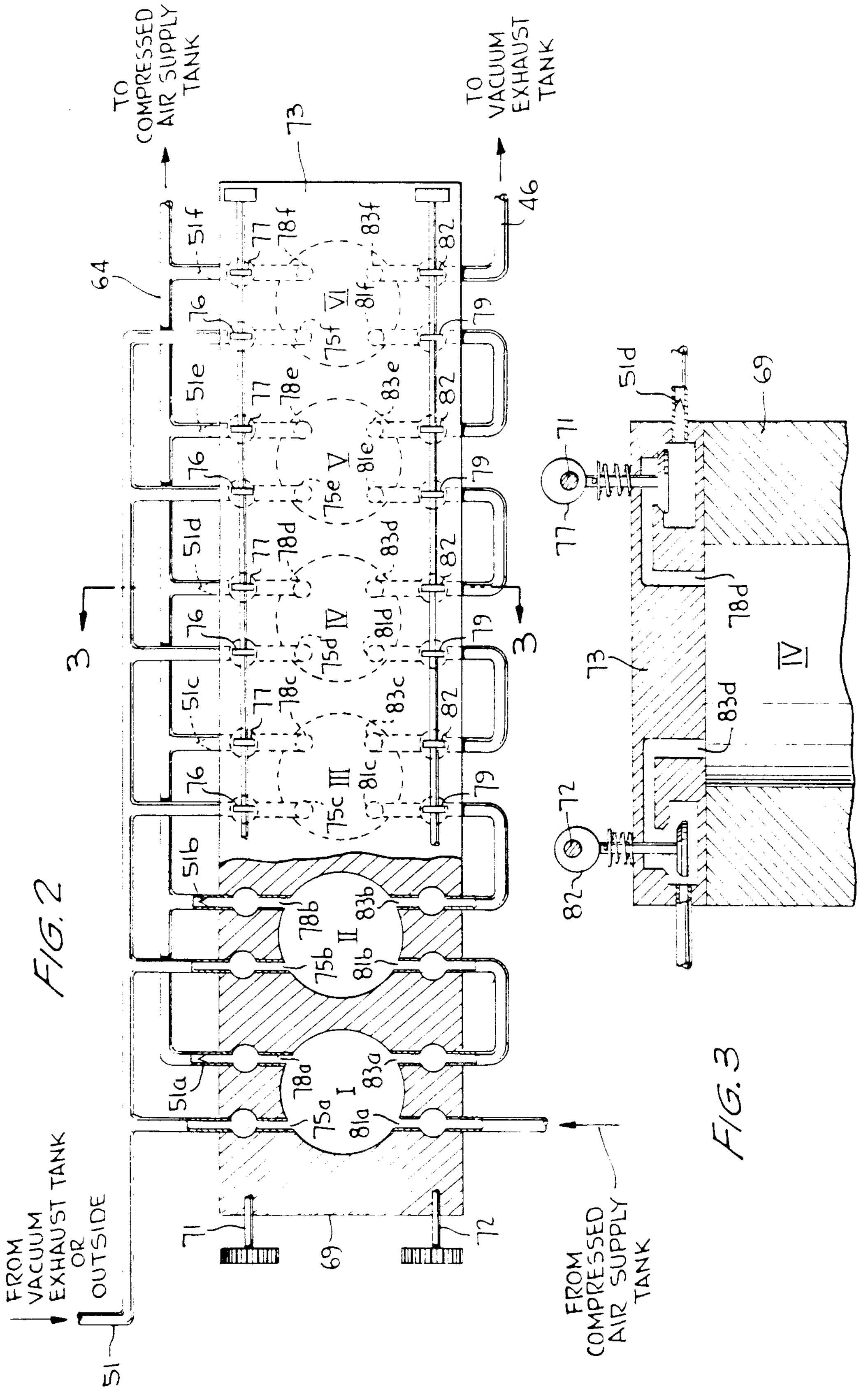

FIG. 2

FIG. 3

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FIG. 4

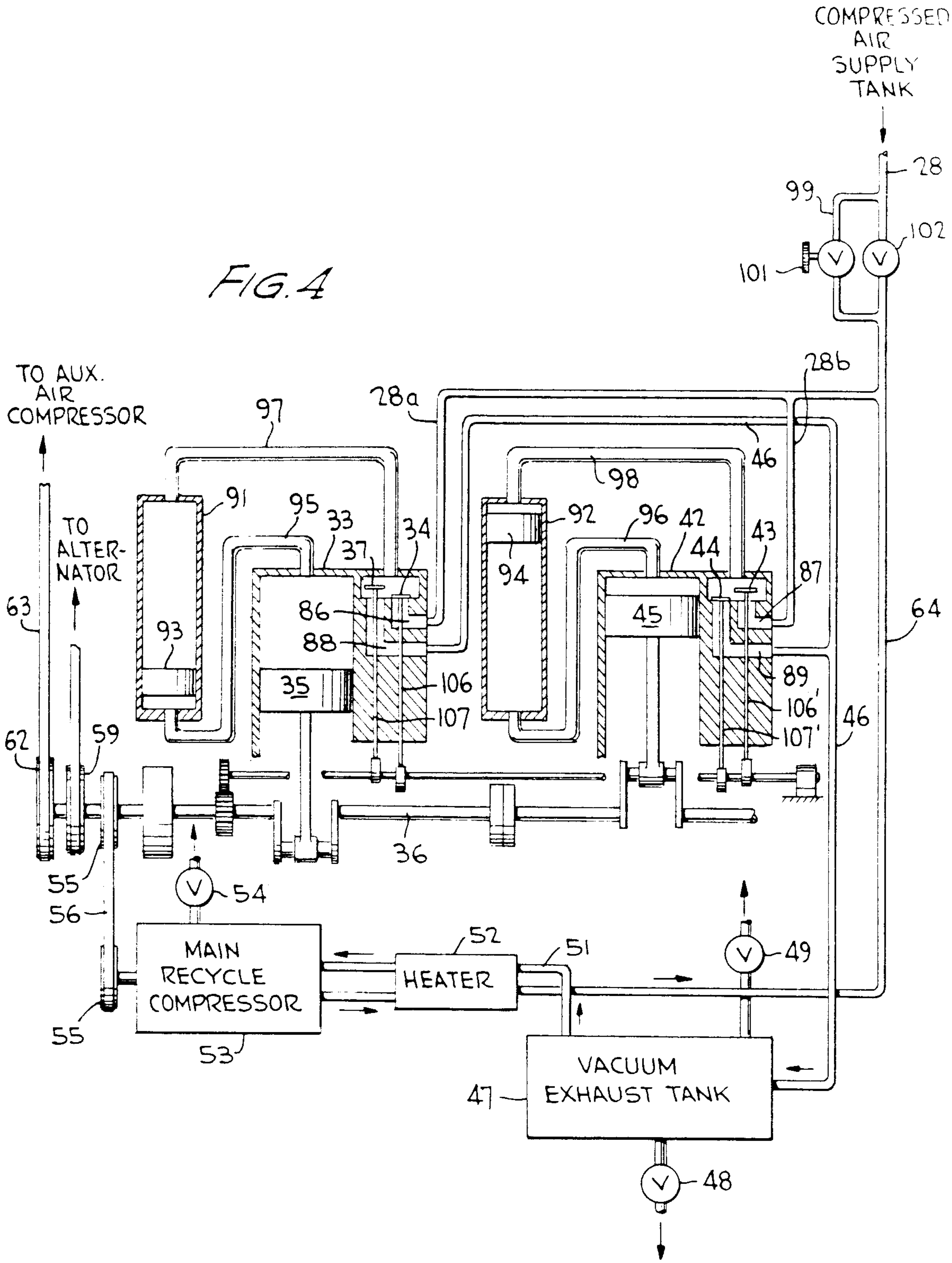

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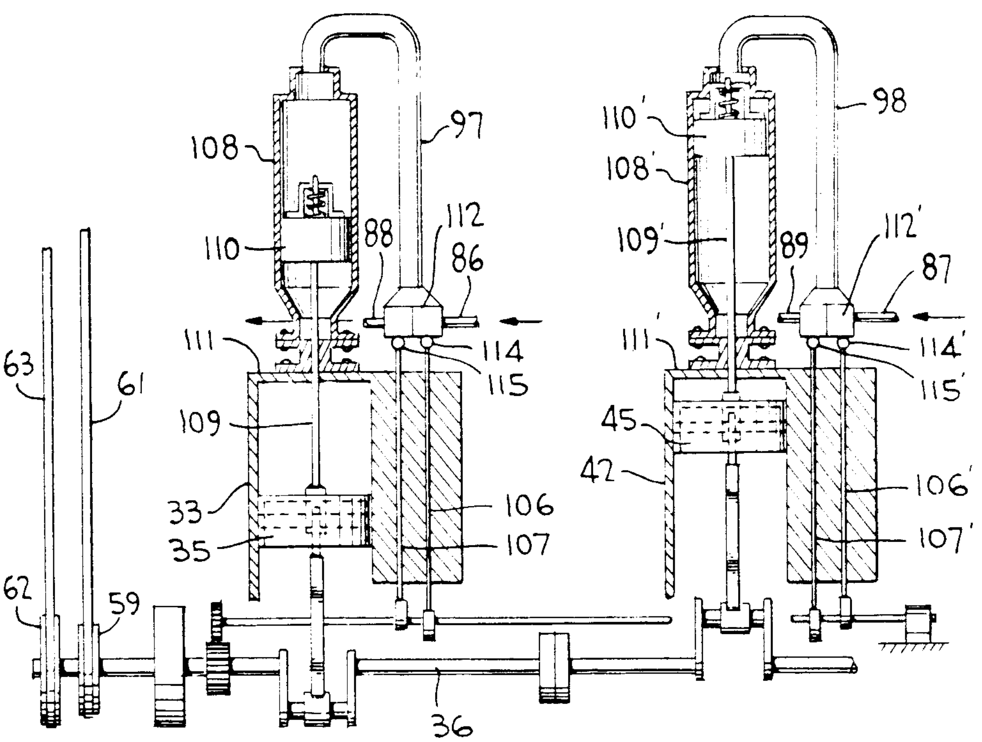
FIG. 5



COMPRESSED AIR ENGINE

This application is a continuation-in-part of my copending application, Ser. No. 113,014 filed Feb. 5, 1971, and now abandoned.

This invention relates generally to compressed air engines and more particularly to such an engine capable of maintaining the pressure in its supply tank at a predetermined level for efficient and continuous operation.

Internal combustion engines for powering motor vehicles and fossil-burning plants used in energy producing operations throughout the industry, have been under attack for many years because of their inherent characteristics which produce air and other pollutants. Steps have been therefore taken to increase the combustion efficiency and filter the exhaust from these power plants with a view to "saving" the atmosphere through more efficient and cleaner burning. The relative success of such operations has, however, been slow and limited because of the many problems which arise. One of the approaches taken in the production of a completely clean power plant is the design of the air engine which is, of course, completely clean since there are absolutely no combustion gasses to contend with. However, design in this area has been somewhat limited because of the reduced power output capable for such engines and because of their somewhat inefficient and complex operation. The air engine has therefore been used in some cases as an auxiliary power plant with a combustion engine or it has been abandoned in favor of other systems because of the auxiliary power needed to maintain adequate supply of air pressure for the system.

A compressed air engine has been therefore devised which avoids all these drawbacks by making use of an auxiliary air compressor started by an electric motor for maintaining a predetermined minimum operating pressure level necessary for the system by simple, efficient and inexpensive means, the electric motor being shut off when this minimum level is reached. This is the principal object of the present invention.

Another object of this invention is to provide such an air engine which makes use of an auxiliary air compressor having two electric clutch means thereon, one through which the auxiliary compressor is driven to fill a compressed air supply tank up to the predetermined minimum level after which the other clutch means takes over through which the auxiliary compressor is again driven for recharging the compressed air supply tank to continue to build up to a maximum predetermined air pressure level and to maintain this level for smooth operation.

A further object of the present invention is to provide such an air engine wherein a main recycle compressor is also made use of for recycling compressed air throughout the system, this recycle compressor taking in air either from the outside for its operation or from a vacuum exhaust tank into which air from the last of the engine pistons exhausts.

A still further object of this invention is to provide such a compressed air engine which makes use of a multicylinder four-cycle engine converted into a four-cycle compressor used in the system, twin cam shafts being used in a conversion head and being properly timed for the intake and exhaust ports of each cylinder.

A still further object of this invention is to provide such an air engine which additionally makes use of hydraulic means as a force-multiplying factor in operating the pistons for increased efficiency.

Other objects, advantages and novel features of the invention will become apparent when the following detailed description of the invention is considered in conjunction with the accompanying drawings wherein:

FIG. **1** is a schematic view showing the various parts of the compressed air engine in accordance with the present invention;

FIG. **2** is a top plan view, partly broken away, of an engine block converted into a four-cycle air compressor;

FIG. **3** is a sectional view taken substantially along the line of **3—3** of FIG. **2** showing a typical cross-section of the conversion head and a part of one of the cylinders;

FIG. **4** is a schematic view showing another embodiment of a compressed air engine in accordance with the present invention; and

FIG. **5** is a schematic view of still another embodiment of a compressed air engine of the invention.

Turning now to the drawings wherein like reference characters refer to like and corresponding parts throughout the several views, there is shown in FIG. **1** a schematic view of an air engine as having a compressed air supply tank **10** into which compressed air is fed up to a predetermined minimum pressure level by an auxiliary air compressor **11.** Compressor **11** is powered by an electric motor **12** which, when energized, rotates drive shaft **13** of the compressor through pulleys **14,** belt **15** and a first electric clutch **16.** This clutch may be of a type which, when energized, is engaged.

To energize motor **12,** an electric switch **17** is actuated which closes the electric circuit for clutch **16** through a closed electric pressure control switch **25,** thereby energizing the clutch for engagement and for closing an electromechanical motor switch **18.** Operation of the electric motor **12** and engagement of first electric clutch **16** drives shaft **13** thereby causing compressed air to be pumped from auxiliary compressor **11** through air line **23** and into the compressed air supply tank **10.** The compressed air may be heated to a predetermined level by means of a coiled heater **24** for purposes of expansion. The compressed air in tank **10** passes through air line **22** and into control switch **25** which remains closed until the pressure builds up to a minimum predetermined level set for minimum operation of the air engine. This switch is designed as having a pressure diaphragm **26** on a contact arm **20** for movement between contact points **103** and **104.** Before the minimum predetermined pressure level is reached, a coil spring **27** maintains arm **20** in contact with **103** whereupon clutch **16** remains energized. The spring force of spring **27** is such as will be overcome by the pressure reaching its predetermined minimum as to cause arm **20** to contact **104.** At such time, the circuit to clutch **16** is broken and accordingly clutch **16** is disengaged whereupon motor **12** is stopped. In the meantime the engine may be caused to idle by the operator at his discretion by closing an electric switch **19** which serves to open a solenoid valve **21** on tank **10** and another solenoid valve **105** in air line **31** to permit air to by-pass a main control valve **102** thereby allowing the

engine to operate at idling speed. A needle valve 101 is provided for adjusting the idle through valve 105.

When motor 12 is stopped, auxiliary air compressor 11 of course also stops. While arm 20 is in contact with point 104 at the minimum predetermined pressure level, the circuit to a second electric pressure control switch 65 is closed through an arm 60 to thereby energize a second electric clutch 68 on drive shaft 13 of compressor 11. Switch 65 is similar to switch 25 in that it includes a diaphragm plate 66 having a contact arm 60 normally maintained in contact with a contact point 106 by means of a coil spring 67. The force of this spring is such that it will not be overcome by the minimum air pressure level but cause the circuit to remain closed until an increased maximum predetermined pressure level is attained. At such time, arm 60 is moved against spring 67 away from contact 106 thereby breaking the circuit and disengaging clutch 68 for stopping compressor 11. Also, as the maximum pressure level drops slightly, clutch 68 will be again engaged since arm 60 will again contact point 106. Compressor 11 will therefore again be turned on to replenish this loss during engine operation.

Compressed air is fed through line 28 and into a coiled heater 29, through line 31 and into the intake port 32 of a first engine piston cylinder 33. Intake valve 34 is designed as being closed when piston 35 of the first cylinder is in its lowermost down stroke as shown. Piston 35 is connected to a crankshaft 36 as is intake valve 34 and an exhaust valve 37, each of which being operable for opening and closing the respective intake and exhaust ports in a conventional manner as by cam lifters as the crankshaft rotates. Air line 38 connects the exhaust port 39 of piston cylinder 33 with the intake port 40 of a second piston cylinder 42 so that, upon the upward stroke of piston 35, compressed air is fed through air line 38 and into second piston cylinder 42 at which time intake valve 43 is opened and exhaust valve 44 is closed, both these valves being connected to crankshaft 36 in a normal manner for opening and closing their respective intake and exhaust ports 40 and 41 via their respective cam lifters from the crankshaft. Upon the upward stroke of piston 45, compressed air is fed through open exhaust port 41 and air line 46 and into a vacuum exhaust tank 47. A drain plug or valve 48 is provided for tank 47 and a maximum vacuum relief valve 49 is also provided in the event it becomes necessary to vent tank 47. Compressed air is then fed through air line 51, which may be heated for expansion by a coiled heater 52, and is fed into a main recycle air compressor 53. A maximum air pressure control valve 54 is provided thereon, and the compressor is operatively connected with crankshaft 36 through pulleys 55 and belt 56. An alternator 57 and a voltage regulator 58 are also operatively connected to crankshaft 36 by means of pulleys 59 and belt 61. Moreover, driveshaft 13 of the auxiliary air compressor 11 is operatively connected with crankshaft 36 via pulleys 62 and a belt 63.

When the air engine is put into operation and clutch 68 is engaged, compressor 11 is belt driven from crankshaft 36 and continues operation to attain the predetermined maximum air pressure and thereafter, intermittently or at frequent intervals, as controlled by switch 65, to replenish any slight losses during engine operation. However, each time the air pressure drops below the predetermined minimum operating level, motor 12 is automatically turned on through pressure control switch 25 as the arm 20 thereof contacts contact point 103 under the action of spring 27. The electric circuit to clutch 16 is then closed and, in the manner as aforedescribed, compressor 11 is turned on through operation of motor 12 to build the pressure back up to the predetermined minimum operating level.

Turning to FIG. 2 of the drawings, a six-cylinder four-cycle engine replacement conversion head 73 which, when adapted to a standard engine block 69, permits it to remain as a four-cycle power stroke and a four-cycle air compressor, or an air engine one-half of the time and an air compressor one-half of the time. This standard engine block is shown as having six cylinder bores I to VI usable in place of the two-cycle cylinders 33 and 42 in the system as described above with reference to FIG. 1. As will be seen, the FIG. 2 arrangement acts as a four-cycle air compressor or an air engine one-half the time and as an air compressor one-half the time thereby eliminating the need for compressor 53. Two standard four-cycle cam shafts 71, 72, properly timed, are provided with respective eccentric cam lobes 76, 77 and 79, 82. Each cam shaft 71 and 72 is operatively connected with crankshaft 36 in timed relation so that, for example, shaft 71 is in phase therewith and shaft 72 is out of phase. Each of the lobes 76 is associated with respective intake ports 75a through 75f, lobes 77 are each associated with respective exhaust ports 78*a* through 78*f*, lobes 82 are each associated with respective intake ports 81*a* through 81*f* and lobes 79 are each associated with respective exhaust ports 83*a* through 83*f*. These lobes are each designed for proper timing so that port 81*a* is open at the top of the power stroke for the piston (not shown) of bore I while the remaining three ports 83*a*, 75*a* and 78*a* are closed during travel of the piston from top to bottom. At the bottom of the power stroke, 81*a* closes and 83*a* opens along with 81*b* allowing exhaust from cylinder I to the next cylinder II in series order. When the piston in bore 1 travels from bottom to the top of its cylinder, port 83*a* closes and, simultaneously, 75*a* opens and remains open as the piston travels from top to bottom of its compression stroke pulling the vacuum from the vacuum exhaust tank 47 or from the outside. At the bottom of the compression stroke ports 75*a*, 81*a*, 83*a* are closed and ports 78*a* opens to exhaust air past a baffle valve 51*a* and through exhaust manifold 64 to the compressed air supply tank 10. When port 81*b* is open (as aforedescribed) the piston in cylinder bore II operates in the same manner as the piston described above in cylinder bore I, and so on for cylinder bores II to VI in series order. For cylinder VI, the exhaust from the power stroke, however, is exhausted into the vacuum exhaust tank 47 from which the pistons of all cylinders pull in outside air or from the vacuum exhaust tank for the intake of the compression stroke.

FIG. 3 is a typical cross-sectional view through the block 69 and conversion head 73 showing only ports 78*d* and 83*d* and baffle valve 51*d*, it being understood that ports 75*d* and 81*d* of cylinder IV are similar in all respects to the ports shown herein but are omitted for purposes of clarity. The remaining cylinders are similarly designed for operation in accordance with the above description.

In the FIG. 2 embodiment, crankshaft 36 is not shown although it is operatively interconnected as in FIG. 1 to each of the six piston rods. The air engine as described in FIG. 1 is otherwise the same except that

the four-cycle six cylinder engine of FIG. 2 is used instead of the two-cycle two cylinder 33, 42 arrangement of FIG. 1 in conjunction with compressor 53.

Another embodiment of the invention is shown in FIG. 4 of the drawings which schematically sets forth thedifferent characteristics of this embodiment as compared to that of FIG. 1. Accordingly, those identical elements including the compressed air supply tank, the electric motor, the auxiliary air compressor and the two electric pressure control switches are not shown and similar elements of FIG. 1 bear the same reference numerals in this Figure.

Instead of piston cylinders 33 and 42 being serially connected as they are in FIG. 1, they are connected in parallel in FIG. 4 so that compressed air through line 28 is fed through lines 28*a* and 28*b* into respective intake ports 86 and 87 of the two piston cylinders. The intake and exhaust valves 34, 43 and 37, 44, respectively, for each of the piston cylinders are operatively connected to crankshaft 36 in the customary manner for opening and closing their respective intake ports 86, 87 and exhaust ports 88, 89 as push rods 106, 107 and 106', 107' are alternately lifted by rotation of their respective cam lobes during crankshaft rotation.

Compressed air through air lines 28*a* and 28*b* is fed through the open one of intake ports 86, 87 and to the top of hydraulic cylinder 91, 92, each of which has a floating piston 93, 94, respectively, therein. The floating piston, for example, 94, as shown in FIG. 4, is pushed downwardly which in turn feeds hydraulic fluid through a fluid line 96 to the top of piston cylinder 42 thereby causing piston 45 to be moved downardly. Piston 35 of cylinder 33 is correspondingly moved upwardly by the crankshaft rotation so as to feed hydraulic fluid through its fluid line 95 and back into cylinder 91 thereby elevating floating piston 93 and forcing the compressed air through its line 97 and through the exhaust port 88 into air line 46 and into vacuum exhaust tank 47 (or to the outside). Floating piston 93 is moved downwardly and floating piston 94 upwardly in reverse order for that described above upon continued crankshaft rotation. The pressure created in the fluid by a small force acting on floating pistons 93 and 94 in their respective cylinders results in a large force on the respective large pistons 34 and 35, thereby effecting a more efficient rotation of crankshaft 36.

The FIG. 1 embodiment may be easily modified to include the hydraulic means as disclosed in FIG. 4 with the use of appropriate plates and gaskets embodying a fluid line 96 and air line 98 for piston cylinder 42, and similar gaskets and plates embodying a fluid line 95 and air line 97 for piston cylinder 33 for diverting the air flow to the hydraulic cylinders instead of directly to piston cylinders 33, 42 as in FIG. 1.

Another embodiment, shown in FIG. 5, demonstrates another type of mechanical advantage developed for the engine pistons, except that the floating pistons of FIG. 4 are eliminated and sealed piston cylinders 108, 108' are each instead connected directly with each piston 35 and 45 located within respective cylinders 33 and 42. Those pistons may be of any desired shape since no rings are needed. Only a wrist pin action (as shown) is designed between the piston and its rod, and a crank action occurs between its rod and the crankshaft. Accordingly, cylinders 33 and 42 respectively act as guides for pistons 35 and 45. Rods 109, 109' of pistons 110, 110' in each cylinder 108, 108' are connected to each of their respective pistons 35 and 45.

As in FIG. 4, rods 106, 106' and 107, 107' are each extended through respective cylinder head plates 111, 111' with each of these rods being in contact with a respective button type air valve 112, 112' as shown. These air valves are each of a conventional design so that, upon upward movement of their respective buttons 114, 114' and 115, 115', air is permitted to flow therethrough.

Intake ports 86, 87 and exhaust ports 88, 89 are respectively located in air valves 112, 112'.

Compressed air through air lines 28*a* and 28*b* (not shown in FIG. 5 for clarity) is fed through the open one of intake ports 86, 87 in valves 112, 112' and to the top of pistons 110, 110' through air lines 91, 98 as one of respective rods 106, 106' is lifted by rotation of its cam lobe during crankshaft rotation. Assuming piston 110' is thereby pushed downwardly, piston 45 is also caused to be moved downwardly. Piston 35 of cylinder 33 is correspondingly moved upwardly by crankshaft rotation at which time its exhaust port 88 is open and its intake port 86 closed by movement of rods 107 and 106 during crankshaft rotation. At the top the stroke of piston 110, port 86 opens and port 88 closes, with the reverse for ports 87 and 89, so that downward stroke of piston 110 may be effected in the same manner as described for cylinder 108'.

It should be understood that the engine in accordance with the FIG. 5 is the same as that of FIGS. 1 and 4 except for those differences as aforedescribed. Accordingly, compressors 11 and 53, switches 25 and 65, tanks 10 and 47, motor 12 and the various air and electrical interconnections are also used for the FIG. 5 embodiment but are not shown for purposes of clarity.

In view of the foregoing, it can be seen that a simple, efficient and highly effective compressed air engine has been devised which makes use of an electric motor for starting an auxiliary air compressor for pressurizing a compressed air supply tank which, after a minimum predetermined pressure level is reached, commences operation of piston cylinders for rotation of a crankshaft. The electric motor is stopped as soon as this minimum predetermined pressure level is reached after which the auxiliary air compressor continues operation from the crankshaft by means of pressure control switches which serve to first de-energize one electric clutch and thereafter energize another electric clutch connected to the compressor. Hydraulic means may be used to increase the moving force on the pistons to effect a more efficient crankshaft rotation, and a conversion head is made use of in converting a standard multicylinder four-cycle engine block into a four-cycle air engine and a four-cycle air compressor for the air engine.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A compressed air engine having engine pistons for rotation of a crankshaft, the engine being characterized by a compressed air supply tank connected with an auxiliary air compressor, first electric clutch means on said air compressor, a switch operated electric motor operatively connected with said air compressor, a first

electric pressure control switch connected with said clutch means, an electric switch for energizing said clutch and the switch of said electric motor thereby actuating said motor for driving said compressor through said first clutch, said tank being connected with said engine pistons in series, means for operating said pistons from said tank after a predetermined minimum air pressure level is reached, a main recycle air compressor interconnected between the last of said series connected pistons and said supply tank for recycling compressed air through the engine, a second electric clutch means on said auxiliary air compressor, and a second electric pressure control switch connected with said second clutch means, said auxiliary air compressor being operatively connected with said crankshaft, said first electric pressure control switch being so arranged as to open to thereby de-energize said first clutch and stop said motor when the pressure in said tank reaches the minimum predetermined operating air level, said second electric pressure control switch being so arranged as to be closed to thereby energize said second clutch at the time said first clutch is de-energized maintaining operation of said auxiliary air compressor from the crankshaft up to a maximum predetermined operating air pressure level, and again starting said auxiliary air compressor when the pressure in said tank falls below said maximum predetermined operating air level.

2. The engine according to claim 1 wherein said main recycle air compressor is operatively connected with said crankshaft.

3. The engine according to claim 1 wherein a vacuum exhaust tank is provided into which said last piston exhausts and from which air is fed into said main recycle air compressor.

4. A compressed air engine having engine pistons for rotation of a crankshaft, the engine being characterized by a compressed air supply tank connected with an auxiliary air compressor, first electric clutch means on said air compressor, a first electric pressure control switch connected with said clutch means, an electric switch for energizing said clutch and the switch of said electric motor thereby actuating said motor for driving said compressor through said first clutch, said tank being connected with said engine pistons in series, means for operating said pistons from said tank after a predetermined minimum air pressure level is reached, a second electric clutch means on said auxiliary compressor, and a second electric pressure control switch connected with said second clutch means, said compressor being operatively connected with said crankshaft, said first electric pressure control switch being so arranged as to open to thereby de-energized said first clutch and stop said motor when the pressure in said tank reaches the minimum predetermined operating air level, said second electric pressure control switch being so arranged as to be closed to thereby energize said second clutch at the time said first clutch is de-energized maintaining operation of said auxiliary air compressor from the crankshaft up to a maximum predetermined operating air pressure level and again starting said auxiliary air compressor when the pressure in said tank falls below said maximum predetermined operating air level, said pistons comprising a multi-cylinder four-cycle engine having intake and exhaust valves for each power stroke thereof, intake and exhaust valves for each compression stroke thereof, and a baffle valve in the exhaust of the compression stroke for each said cylinder, a camshaft for said power stroke valves and another camshaft for said compression stroke valves, cam lobes on each said camshaft arranged to open and close said valves during the power and compression strokes in series order upon rotation of said camshaft.

5. A compressed air engine having engine pistons for rotation of a crankshaft, the engine being characterized by a compressed air supply tank connected with an auxiliary air compressor, first electric clutch means on said compressor, a switch operated electric motor operatively connected with said air compressor, a first electric pressure control switch connected with said clutch means, an electric switch for energizing said clutch and the switch of said electric motor thereby actuating said motor for driving said compressor through said first clutch, said tank being connected with said engine pistons in parallel, fluid means for operating said pistons from said tank after a predetermined minimum air pressure level is reached, means associated with each of said engine pistons for actuating said pistons, a main recycle air compressor interconnected between said parallely connected pistons and said supply tank for recycling compressed air throughout the engine, a second electric clutch means on said auxiliary air compressor, and a second electric pressure control switch connected with said second clutch means, said auxiliary air compressor being operatively connected with said crankshaft, said first electric pressure control switch being so arranged as to open to thereby de-energize said first clutch and stop said motor when the pressure in said tank reaches the minimum predetermined operating air level, said second electric pressure control switch being so arranged as to be closed to thereby energize said second clutch at the time said first clutch is de-energized thereby maintaining operation of said auxiliary air compressor when the pressure reaches a minimum predetermined level from the crankshaft up to a maximum predetermined operating air pressure level and again starting said auxiliary compressor when the pressure in said tank falls below said maximum predetermined operating air pressure level.

6. The engine according to claim 5 wherein said main recycle air compressor is operatively connected with said crankshaft.

7. The engine according to claim 5 wherein a vacuum exhaust tank is provided into which each of said pistons exhaust and from which air is fed into said main recycle air compressor.

8. The engine according to claim 5 wherein said fluid means comprises a hydraulic cylinder for each said piston at least partially filled with hydraulic fluid and having a floating piston therein for forcing the fluid from said hydraulic cylinder into its connected piston cylinder upon movement of said floating piston by the compressed air from the supply tank.

9. The engine according to claim 5 wherein said fluid means comprises a sealed air cylinder having a piston therein connected to each said engine piston which acts as a guide for its respective air cylinder piston, the downward movement of the power stroke of each said engine piston being actuated by its respective air cylinder piston.

* * * * *

THE DAILY HERALD

Biloxi-Gulfport, Miss., Tuesday, July 1'

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Machine — runs on compressed air?

GENE SWEARINGEN
Herald Staff Writer

In 1900, Henry Ford's name was not exactly a household word. Seventy-nine years later, neither is Samuel David Todd's. What Ford went on to accomplish is documented in volume after volume. Todd's documentation starts here and if history is a reliable measure, may well end here.

Todd, of 1913 44th Ave., Gulfport, says he has "figured out a way to mobilize" dead weight using compressed air and hydraulic action.

He says he built a machine that "rode me up and down the road" at 20 to 25 mph and that once started the machine could run indefinitely without any external energy source.

Yet, he said he destroyed the prototype when he found that some children were playing around the shed where it was located and he was afraid his idea would be stolen.

He said his design is "in the T-Model stage right now and a fellow could run into trouble with a loss of power if he didn't know what he was doing," but a tank of compressed air would get it started again and a knowledgeable driver could make it "run without stopping, indefinitely."

Coast to coast without a fuel stop? "Yes," Todd said, and back again, and back again, and . . .

According to Todd, air is compressed in his machine by hydraulic action, and as hydraulic pressure is lost, or 'used up,' the compressed air is used to rebuild pressure.

His description sounds remarkably like the impossible dream man has followed for centuries but Todd denies that he has mastered perpetual motion.

"I don't believe in perpetual motion," Todd said, and in that he is in total agreement with the first and second laws of thermodynamics which, though far beyond my comprehension, hint rather strongly that you don't get something for nothing, a fact that has not deterred people from trying for centuries.

In the 13th century, Villard de Honnecourt, a French architect, designed his version of a perpetual motion machine that featured seven pivoted hammers arrayed around a mounted wheel.

Honnecourt knew that a weight attached near the top of a balanced wheel would cause it to rotate downward until the weight reached the bottom.

He reasoned if the weight could be brought toward the center of the wheel on the upward swing while another weight stuck out on the downward side, the overbalanced wheel would keep on turning.

Honnecourt's problem, however, was that the hammers merely increased the friction without helping the action.

The most simple perpetual motion machine would be a disk mounted on frictionless bearings in a perfect vacuum. If these conditions could be met the worth of the machine would be questionable because any load (a requirement to do work)

placed on the device would drag it to a halt.

Still, men try. Even Leonardo da Vinci, in the 15th century, designed a machine with mercury-filled balls at the end of four radial arms attached to a wheel. The shifting weight of the liquid metal was supposed to keep the wheel spinning.

Hundreds of other attempts have been recorded and perhaps the worst indictment against perpetual motion is that to date, even in this era of long lines and high fuel costs, all claims for such machines have been unable to pass scrutiny.

But many "facts" of the past are looked on today with ridicule and, again, Todd says his machine is not perpetual motion.

"I accidently ran into this while working on a double engine pan used to haul dirt," Todd said. He was working on the front engine while two other mechanics were working on the rear. "They hooked up the hydraulics wrong and the machine took off without either of the engines running," Todd said.

He said it took him nine years to "figure out the principles involved" and build a working model. After testing the machine, Todd said he destroyed it because "some kids were monkeying around the shed where I kept it and I was afraid my idea would be stolen."

Todd has been a diesel mechanic and heavy equipment operator all his life and is a disabled veteran of World War II. He says he needs "about $20,000 to $25,000" to obtain mechanical dra[illegible] patent rights and build another model. "The[illegible] still some monkeys in it," Todd said, "B[illegible] monkeys can be got out."

Todd said anybody interested in his ma[illegible] could write to him in Gulfport. He is sc[illegible] financing.

He said his concept could be used to power [illegible] trailers or any other type of conveyance. "It [illegible] have to be something in motion," Todd expl[illegible] "not stationary like an electric generating p[illegible] He said if it "set up for a while, like a mo[illegible] another shot of compressed air would be req[illegible] to start it up again. "But once set in motion[illegible] repeated, "It can be operated indefinitely.'

"This gas mess makes me mad," Todd [illegible] "Having to wait in lines. My machine will st[illegible] that."

Perhaps. But if the past is an indicator T[illegible] machine will not be on the market anytime [illegible] Ford built his first car in 1896 but not until [illegible] did his Model-T change society forever.

Worse still, the Greek scientist Hero bu[illegible] working model of a steam turbine during [illegible] century after Christ. It was 1,700 years b[illegible] James Watt, a Scottish engineer, put the id[illegible] work.

It would also require time for the local go[illegible]ment to determine the best method of apply[illegible] seawall tax to air.

"...the cost was reduced to one-half, and the rate of boring was three times as fast when compressed-air machinery replaced hand labour. In such cases the advantage is so great, even with uneconomical machinery, that the inducement to adopt very perfect machinery is absent. Hence much of the air-compressing plants at mines has been unnecessarily inefficient and wasteful of power."

William Unwin, 1894
"Development and Transmission of Power from Central Stations"

United States Patent [19]

Simington

[11] **3,885,387**

[45] **May 27, 1975**

[54] **AIR DRIVE ADAPTOR**

[76] Inventor: **Garnet J. Simington**, General Delivery, Lethbridge, Alberta, Canada

[22] Filed: **June 22, 1973**

[21] Appl. No.: **372,559**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 182,387, Sept. 21, 1971, abandoned.

[52] **U.S. Cl.** **60/370;** 60/407; 60/412; 123/DIG. 7

[51] **Int. Cl.** **F15b 1/20**

[58] **Field of Search** 123/DIG. 7; 137/627; 60/327, 369, 370, 371, 407, 408, 412

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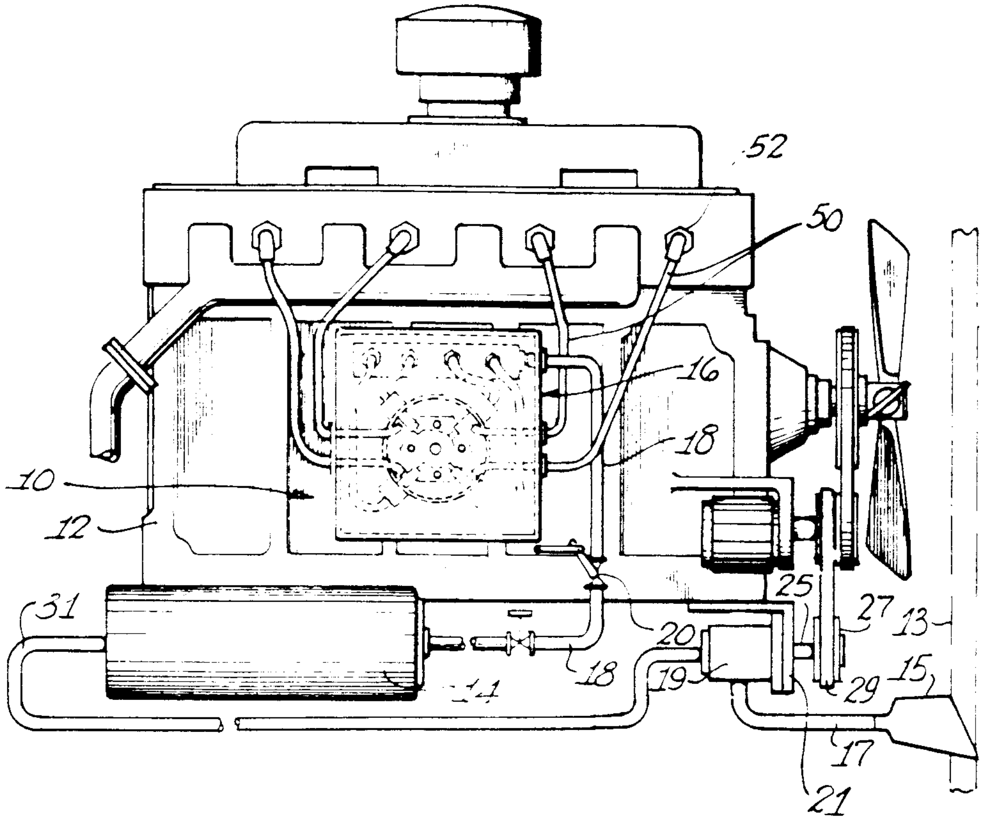
Primary Examiner—Edgar W. Geoghegan

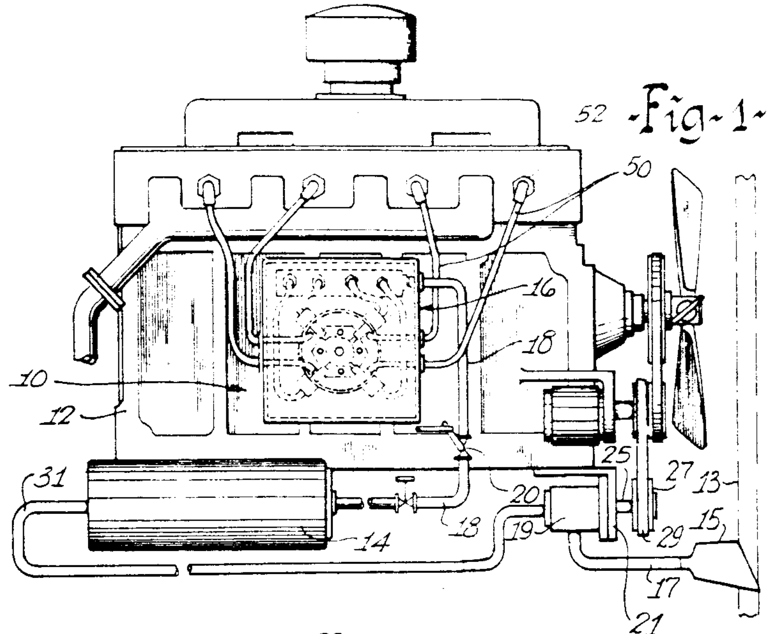
[57] **ABSTRACT**

An apparatus is disclosed for adapting an internal combustion engine for operation on compressed air. The apparatus includes a source of compressed air, valving means for introducing the correct amount of air into the cylinders and valve actuation means to cause timed opening of the valve means for introducing compressed air to the appropriate cylinders at the correct time. The apparatus is constructed so that it can be readily mounted on or removed from the engine thereby allowing portability from one engine to another or conversion of the engine back to operation on a combustible fuel.

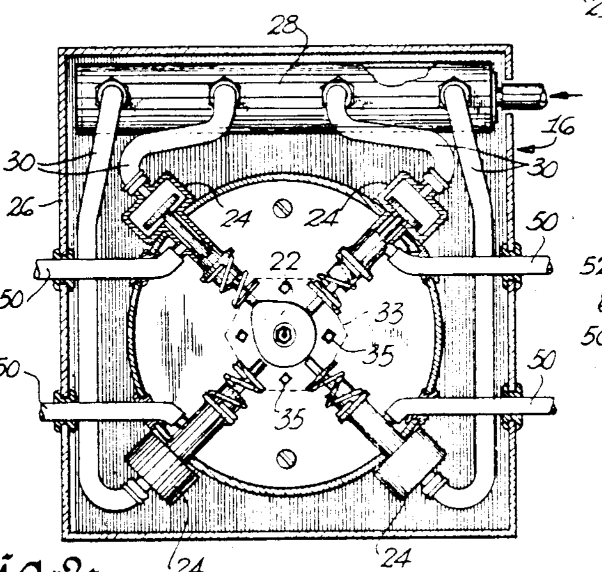
3 Claims, 4 Drawing Figures



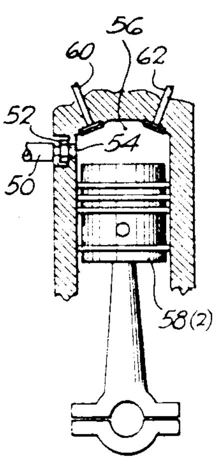
PATENTED MAY 27 1975 3,885,387



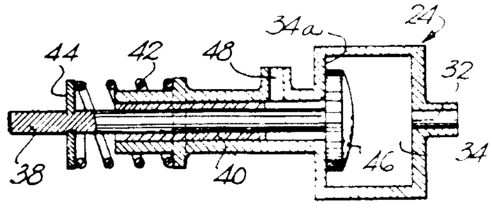
-Fig-1-



-Fig-2-



-Fig-4-



-Fig-3-

AIR DRIVE ADAPTOR

The present application is a continuation-in-part of my copending application Ser. No. 182,387 filed Sept. 21, 1971, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to engines and more particularly to apparatus for converting an internal combustion engine for operation with a compressed noncombustible gas.

Air pollution is one of the most serious problems facing modern humanity and, as is well known one of the greatest contributors to air pollution is the automobile engine. In the vast majority of automobiles and other self-propelled vehicles, the motive power is obtained through operation of an internal-combustion engine with high or medium octane gasoline as the fuel. The internal-combustion engine is not noted for its efficiency in obtaining useful work from the energy available through combustion and as a consequence of this inefficiency many unburnt hydrocarbons are exhausted into the air. Gases such as carbon monoxide and nitrogen dioxide are harmful to animal and plant life, thereby contributing to a breakdown in the ecology of this planet.

The transportation industry is extremely large and wields considerable power and influence, so it is doubtful whether it will introduce non-legislated changes in the product in which it has heavily invested. It therefore rests with the individual to either lobby for more efficient motive power for his automobile (which will be around for many years) or to modify the engine he is now using to run more efficiently and hopefully aid in the reduction of air pollution.

BRIEF SUMMARY OF INVENTION

The present invention provides a specific apparatus, easily and removably adaptable to an internal combustion engine whereby motive power is derived from the energy released upon expansion of a compressed gas such as air. The apparatus includes a source of compressed air, a valving and valve actuation mechanism and means to introduce the compressed air into the cylinders of the engine. For simplicity and removability, the air is introduced through the spark plug holes during the power stroke of the engine cycle.

With such an apparatus installed in an automobile, pollution due to unburnt hydrocarbons is eliminated and more efficient energy conversion is obtained. In addition, the noise level in the vicinity of the automobile is drastically reduced since much of the sound of an internal-combustion engine is the result of detonating the fuel-air mixture. Also the adaptor may be removed from the vehicle for attachment to another vehicle, thereby reducing the overall cost to the consumer since he doesn't have to purchase a new unit each time he purchases a new vehicle, providing there is no change in the number of cylinders in the power plant. Removal of the adaptor of the present invention also will permit the engine, with little effort, to be again operated as a combustion engine should the necessity arise.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described in greater detail with reference to the drawings wherein:

FIG. 1 is a side view of a four cylinder I-C engine with apparatus of the invention mounted ~~thereon~~.

FIG. 2 is an enlarged view of the apparatus of the invention.

FIG. 3 is an enlarged view of an air distribution valve used in the apparatus of the invention.

FIG. 4 is a view of a piston and cylinder in the engine.

DETAILED DESCRIPTION OF INVENTION

With reference now to FIGS. **1** and **2**, a preferred embodiment of the apparatus of this invention is shown generally as reference numeral **10**, mounted on a standard four-cylinder automobile engine **12**.

Mounted in or below the grill **13** of the vehicle is an air scoop **15** connected via conduit **17** to an air compressor **19**. The air compressor may be driven by a small gasoline engine or electric motor if it is located in the trunk of the vehicle or by an electric motor, or by the fan belt if it is located in the engine compartment. In FIG. **1** the air compressor **19** is shown as mounted on a bracket **21** which may be bolted to the engine **12**. Shaft **25** of the compressor is provided at its outermost end with a pulley **27** such that the compressor may be driven therethrough by fan belt **29**. From the outlet of compressor **19**, conduit **31** leads to tank **14** which acts as an accumulator and hence is a source of compressed air for the engine.

The source **14**, is attached to the vehicle wherever convenient. It is shown in FIG. **1** as detached from the engine, logical areas for its location being the trunk or the engine compartment. If a pre-charged tank of compressed air is used mileage obtained from the tank is directly related to the available volume of the tank. Source **14** is connected to valving means **16** via flexible high pressure hose **18**, in which, and secured to the vehicle, is a throttle valve **20**. This valve is connected through linkages (not shown) to the accelerator pedal in the passenger compartment and meters the volume, and hence the pressure, of air permitted to flow through the valving means **16**. In a normal manner the accelerator pedal is used to alter the output of the engine in response to load demands.

Valving means **16** is especially adapted to be interchangeable from engine to engine thereby obviating the necessity of purchasing a new adaptor each time a new vehicle is purchased. Since spark plugs are not longer required there is no requirement for a distributor and hence the valving means **16** can be attached to the engine in place of the distributor. Bracket means, appropriately sized to the individual engine make, and shown as character **33**, is mounted to the engine in place of the distributor, but in such a manner that the distributor drive is still available. The valving means **16** is then attached, as by bolts **35** to the bracket in such a manner that it can be readily removed therefrom, the bracket itself, in turn, being readily removable from the engine block.

Valving means **16**, in conjunction with valve actuation means **22** and throttle valve **20** provides the correct volume of air to the correct cylinder at the correct time. Valving means **16** includes a plurality of air distribution valves **24**, one for each cylinder, the valves being housed within metal block or housing **26**. Block

26 may be cast and/or machined from any appropriate metal and receives bolts 35 for mounting the valving means 16 to the vehicle. Within, or attached to block 26 is a manifold 28 connected to flexible hose 18 and to each valve 24 via pipes or flexible hoses 30.

Air distribution valve 24 is shown in cross-section in FIG. 3. It includes an inlet 32 connected to flexible hose 30 for introducing air into chamber 34. A valve guide 40 extending from the side of chamber 34 opposite to inlet 32 houses valve stem 38 and provides a cylindrical, yet annular, core for valve spring 42. Spring 42 is a compression spring acting on washer and keeper 44 fixed to stem 38 to maintain the valve in a normally closed state with curved closure plate 46 abutting wall 36 of chamber 34. In this condition compressed air in chamber 34 is prevented from entering outlet 48 which is, in turn, connected via pipe or flexible hose 50 to adapter 52 in spark plug hole 54.

Valve actuation means 22 may be a cam driven from the existing crankshaft of the engine or as is preferable, from the distributor drive to provide operation of each valve 24 in its proper sequence. In the standard four cycle engine operating on a combustible fuel, two revolutions of the crankshaft are required to fully complete the four cycles. On the first revolution fuel-air mixture is introduced into the cylinder and it is then compressed. On the second revolution, the compressed mixture is detonated by the spark plug giving the power stroke to the piston and the expanded gases are then exhausted.

Since the compressed air utilized in the present invention must expand to deliver its energy, it must be introduced into the cylinder 56 when piston 58 is at top-dead-center, ready to begin its power stroke. In the following description, pistons 58 are referred to as pistons 58(1), 58(2), 58(3) and 58(4) to indicate the specific pistons in a four cylinder engine, from front to back. The pistons are not shown, except for piston 58(2) as in FIG. 4. With valve actuation means 22 rotating as shown in FIG. 1, piston 58(2) is almost at top-dead-center, ready to receive its charge of compressed air. Piston 58(1) is ready to begin a compression stroke, compressing atmospheric air brought in through inlet valve 60 during its intake stroke. Piston 58(3) is ready to commence an intake stroke and piston 58(4) is nearing the end of its power stroke and is ready to deliver an exhaust stroke to exhaust the expanded air to atmosphere through exhaust valve 62. With inlet valve 60 open to the atmosphere, outside air is drawn into cylinder 56 on the intake stroke and, with valve 60 closed, is compressed during the compression stroke of piston 58, being augmented by compressed air at considerably higher pressure from source 14 for the power stroke. All air in cylinder 56 is exhausted to atmosphere on the exhaust stroke.

Starting an engine fitted with the adaptor of the present invention is accomplished in the usual manner. The existing starter motor will turn the engine over and operate the compressor so that the tank 14 is properly charged. Valve actuation means 22 also rotates at this time and thus permits a charge of compressed air to enter the cylinders and after the starter motor is disengaged, the engine will sustain itself in operation, as long as the air pressure in tank 14 is sufficient. The compressor 19 could also be provided with clutch means, not shown, such that it would operate only when the pressure in tank 14 falls below a predetermined minimum, there being appropriate sensors and control means for ensuring proper engagement of the clutch.

While the valving means 16 is shown as being adapted for use with a four-cylinder engine, it is understood that the invention is equally applicable to engines having a different number of cylinders. The only change would be in the block 26 and the number of valves 24 provided. An appropriate valving means could also be provided for a rotary engine, many of which are now being sold.

I claim:

1. Apparatus removably adaptable to an internal combustion engine having at least one cylinder containing a piston reciprocable therein, an intake valve, an exhaust valve and a hole for reception of a spark plug, said apparatus comprising a source of compressed, non-combustible gas, valving means including a manifold and at least one gas distribution valve, said gas distribution valve being connected to said cylinder at said hole and to said manifold, said manifold also being connected to said source of compressed gas, and valve actuation means connected to said gas distribution valve, said gas distribution valve upon actuation by said valve actuation means permitting introduction of said compressed gas through said spark plug hole from said manifold into said cylinder when said intake and exhaust valves are closed and said piston is in a position to provide a power stroke in said engine.

2. Apparatus according to claim 1 including bracket means attachable to said engine, said valving means including a housing attachable to said bracket means, said gas distribution valve being cam-operable and mounted in said housing for permitting flow of said compressed gas from said manifold to said spark plug hole.

3. Apparatus according to claim 2 wherein said valve actuation means includes a cam connectable to the distributor drive of said engine, said cam being engagable with said gas distribution valve for actuation thereof.

* * * * *

United States Patent [19]

Holleyman

[11] **3,925,984**

[45] **Dec. 16, 1975**

[54] **COMPRESSED AIR POWER PLANT**

[76] Inventor: **John E. Holleyman**, 3402 Polk St., Monroe, La. 71201

[22] Filed: **Dec. 10, 1974**

[21] Appl. No.: **530,561**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 419,551, Dec. 5, 1973, abandoned.

[52] **U.S. Cl.** .... **60/370**; 60/371; 60/412; 180/66 B

[51] **Int. Cl.**^{2} **F15B 11/06**

[58] **Field of Search** .... 60/412, 325, 370, 371, 60/407, 409, 413, 416; 180/66 B

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Primary Examiner—Edgar W. Geoghegan
Attorney, Agent, or Firm—Raymond N. Matson

[57] **ABSTRACT**

A compressed air power plant for land, air and marine vehicles which is extremely efficient and 100% pollution free so as to be ecologically invaluable. The power plant operates on compressed air from tanks replenished by battery powered air compressors operating in two consecutive or simultaneous stages.

9 Claims, 7 Drawing Figures

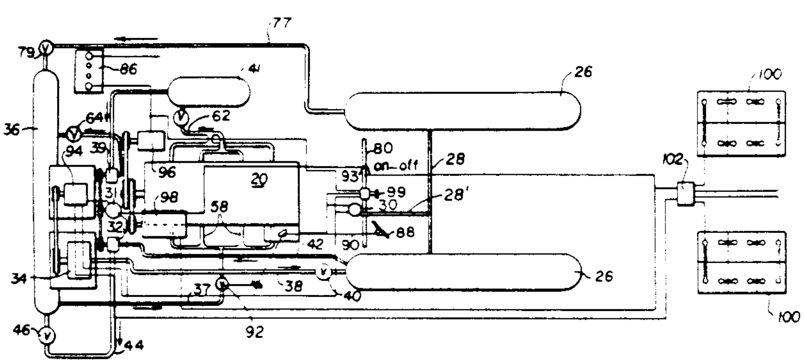

FIG 1

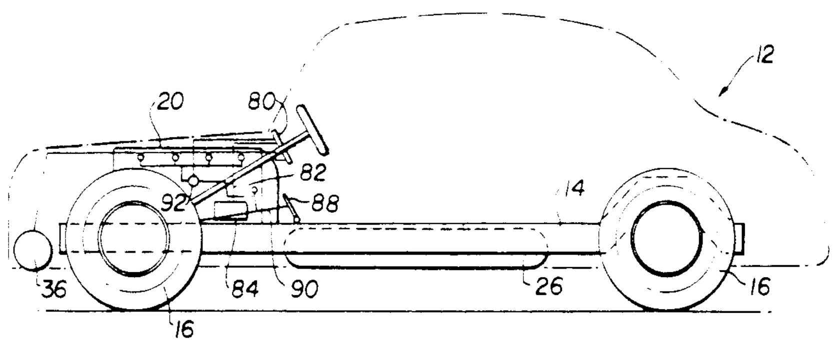
12
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FIG 2

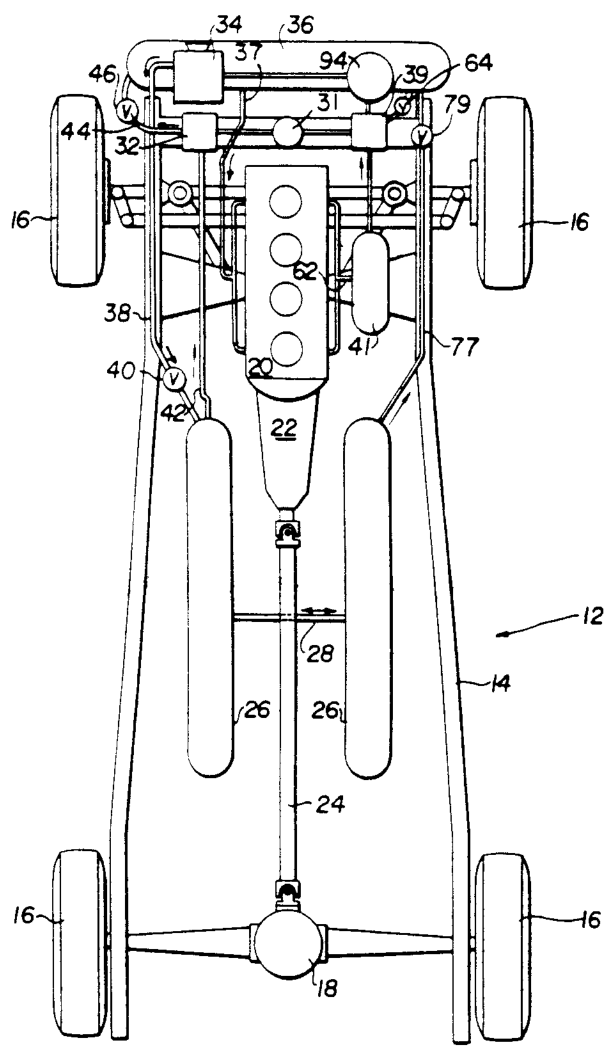
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FIG 3

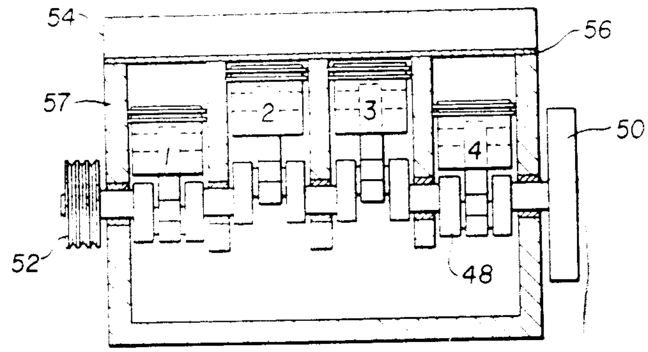
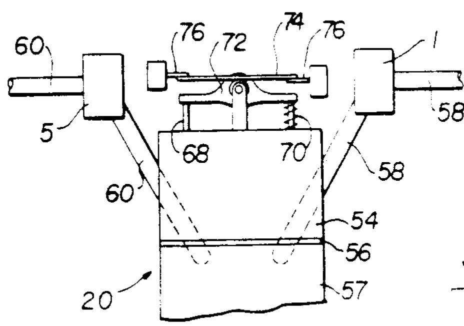


FIG 4



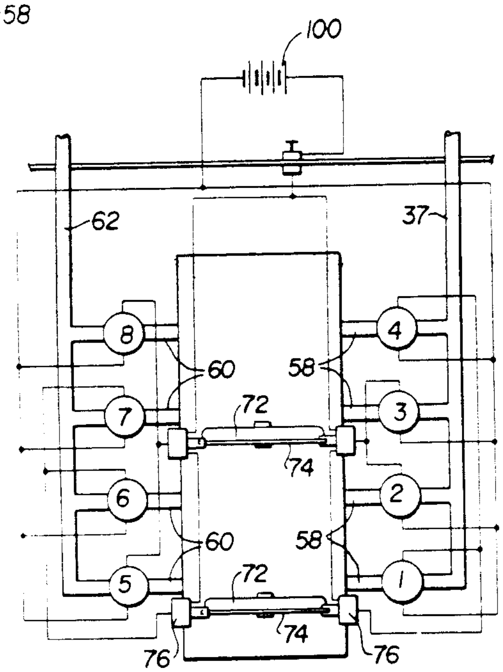


FIG 5

FIG 6

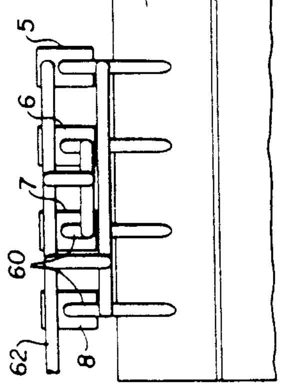
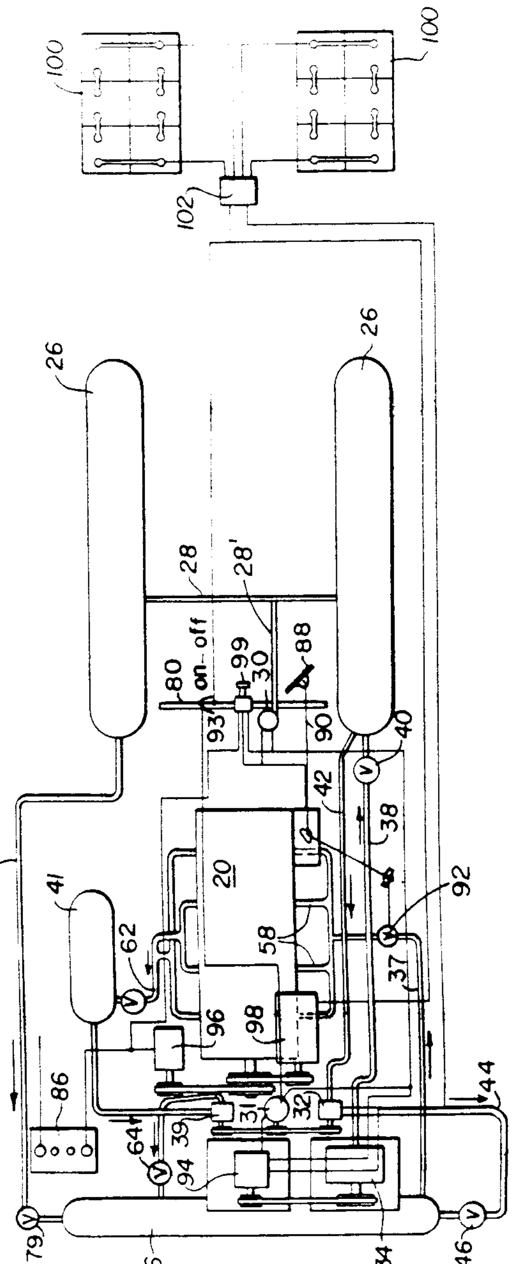


FIG 7



COMPRESSED AIR POWER PLANT

This application is a continuation-in-part of application Ser. No. 419,551 filed Dec. 5, 1973, now abandoned.

This invention relates generally to power plants for land, sea and air vehicles and more particularly to a piston type engine powered by compressed air from a self-replenishing system.

Power plants of this general type are known in the art but have not had general acceptance for a number of reasons. Among these are: an unacceptably low efficiency in operation; an impractical arrangement and use of associated elements; a severe limitation as to running time due to ill-conceived, non-existent or inadequate compressed air replenishing means; and to poor engineering.

Accordingly, the main object of the present invention is to provide an improved compressed air power plant which obviates the disadvantages and inadequacies of known systems.

An important object of the present invention is to provide an improved, highly efficient power plant which is self-replenishing and will run for practical periods of time after which energy providing batteries may be readily recharged or replaced.

A further important object of the present invention is to provide an extremely efficient compressed air power plant from a conventional internal combustion engine by eliminating the conventional ignition system, carburetor, cooling system, etc. and substituting therefor means for providing compressed air to and from the pistons and suitable controls therefor to effect rotation of the crankshaft and drive shaft thereof and propulsion of the vehicle.

A still further important object of the present invention is to provide a simple, efficient, relatively lightweight compressed air propulsion system for vehicles which eliminates a conventional cooling system and the exhaust fumes of an internal combustion engine while providing the flexibility and reliability thereof.

Other objects and advantages of the present invention will become apparent during the course of the following description.

In the drawings I have shown one embodiment of the invention.

In this showing,

FIG. 1 is a diagrammatic side elevational view of the compressed air power plant as applied to a land vehicle;

FIG. 2 is a diagrammatic plan view thereof showing the basic elements of the power plant with certain parts omitted for clarity;

FIG. 3 is a central vertical sectional view to an enlarged scale of the piston type engine which is powered by compressed air;

FIG. 4 is a fragmentary diagrammatic end view thereof showing the intake and exhaust conduits and 12 volt solenoid operated valves for compressed air, and the rocker arm closed electric switches which control the intake and exhaust valves;

FIG. 5 is a diagrammatic top plan view thereof;

FIG. 6 is a diagrammatic side elevational view of the compressed air exhaust line and exhaust frame;

FIG. 7 is a diagrammatic top plan view of the control and drive means for the basic elements of th[illegible] with certain parts being omitted for clarity.

Referring to FIGS. 1 and 2 of the drawings, there is shown a land vehicle such as a conventional internal combustion engine auto 12 converted for use by compressed air power which includes the usual chassis 14, supporting wheels 16, differential 18, piston type engine 20, transmission 22, and connecting drive shaft 24.

In addition to the converted engine 20, the chassis 14 supports the other basic elements of the present invention (FIG. 2) which include a pair of low pressure compressed air tanks 26 connected by a conduit 28 having a dash mounted air pressure actuated switch valve 30, a low pressure compressor 34 being the main compressor, a high pressure pump 32 driven by a motor 31, and a high pressure compressed air tank 36. The main compressor 34 is connected to one of the low pressure tanks 26 by a line 38 having a check valve 40 and the same low pressure tank 26 is connected to the high pressure pump 32 by a line 42 and thence to the high pressure tank 36 by a line 44 having a check valve 46.

The converted internal combustion engine 20 shown is timed along with its rebuilt camshaft (not shown) to inject cylinders number 1 and 4 (FIGS. 3 and 5) at the same time with compressed air from high pressure tank 36 through line 37 (FIG. 7) to drive them downwardly and as they return toward the top of their stroke, their valves are opened to exhaust and compressed air is exhausted to the exhaust tank 41 from where it is pumped by means of high pressure exhaust pump 39 back through check valve 64 into high pressure tank 36. Compressed air is then admitted to cylinders 2 and 3 which move downwardly to thus rotate the crankshaft 48, its fly-wheel 50 and at its opposite end, a three belt pulley 52.

As seen in FIGS. 4 and 5, the engine 20 includes a head 54, an intermediate spacing plate 56, a block 57, 12 volt intake solenoid operated valves 1, 2, 3 and 4 mounted in manifold lines 58, exhaust 12 volt solenoid operated valves 5, 6, 7 and 8 mounted in manifold exhaust lines 60 (FIGS. 5 and 6) which connect with exhaust line 62 which connects into exhaust tank 41 (FIG. 7) and then to high pressure exhaust pump 39 which pumps the exhaust air into the high pressure tank 36 by way of the check valve 64. The exhaust air is pumped to the tank 36 by the high pressure exhaust pump 39, powered by a 36 volt electric motor 31 which has as its source of energy, six 6-volt batteries.

The solenoid operated valves are controlled by the camshaft (not shown) through push rods 68 (FIG. 4) having a return spring 70 which actuate two rocker arms 72 each of which is provided with a switch plate 74 in the form of a ⅛ inch steel bar welded to each. Projecting toward and under the ends of the switch plates 74 from the solenoid operated valves 1, 3, 5 and 7 are relay switch contacts 76. As seen in FIGS. 4 and 5, intake solenoid operated valves 1 and 4 will be opened and closed by the lower intake relay switch 76 while at the same time exhaust solenoid valves 6 and 7 will be opened and closed by the upper relay switch 76.

When intake solenoid operated valves 1 and 4 open, allowing 500 to 700 p.s.i. of air pressure into number 1 and number 4 cylinders (FIGS. 3, 4 and 5), exhaust solenoid operated valves 6 and 7 open at the same time allowing the remaining air under pressure in number 2 and number 3 cylinders to be forced back into the exhaust tank 41 and pumped out by high pressure exhaust pump 39 through check valve 64 into high pressure tank 36. Similarly and in turn, intake solenoid operated valves 2 and 3 are operated by their push rod 68 to

admit air pressure into cylinders 2 and 3 while the rocker arm 72 operates the upper exhaust relay switch 76 to open and close solenoid operated valves 6 and 7, allowing the remaining air pressure in number 1 and number 4 cylinders to pass into exhaust tank 41 and then be pumped by high pressure exhaust pump 39 into tank 36.

The compressed air power plant is readily adapted to a land vehicle such as an auto as shown in FIG. 1. The normal controls are positioned on a dash board 80 with a wire 82 to an electric starter 84 powered by a 12 volt battery 86. The accelerator pedal 88 is connected by a rod 90 to an accelerator valve 92 which controls the flow of compressed air from the high pressure tank 36 through the line 37 to the engine pistons.

The main compressor 34 pumps compressed air from its air inlet through line 38 and check valve 40 into the low pressure tanks 26 which are connected by line 28 and by line 77 initially into tank 36 until the pressure reaches about 150 p.s.i. at which time the air pressure switch 30 mounted on the dash 80 cuts off the 36 volt electric motor 94 driving the main compressor 34. Conversely, when the pressure in the tanks 26 falls below 125 lbs. p.s.i., the air pressure switch 30, being responsive to the pressure in line 28 through line 28' cuts the main compressor 34 back on.

When the higher pressure is reached, and the main compressor 34 shuts off, this will be apparent to the vehicle operator who will then manually turn on a switch 93 mounted on the dash board 80 to turn on the high pressure pump 32 which is driven by the motor 31 (FIG. 7). This will raise the pressure in the high pressure tank 36 to over 500 p.s.i.

In the operation of the compressed air power plant as applied to the auto shown, and assuming that all compressed air tanks are empty and the batteries charged, the main compressor 34 which is powered by one of the 36 volt battery packs 100, is turned on by a dash board switch 99. When the air pressure is sufficient in all tanks as indicated above, the starter 84 (FIG. 1) is energized to start the engine 20 turning at which time the accelerator valve 92 (FIG. 1) will only close approximately 70% allowing only 200 p.s.i. air pressure through the intake line 37 to idle the engine.

A 36 volt motor 31 powered by six 6 volt batteries drives the high pressure exhaust pump 39 which pulls air out of exhaust tank 41 back through the check valve 64 into the high pressure tank 36. Upon operation of the main compressor 34, the first low pressure tank 26 builds up pressure, which will pass to the second low pressure tank 26 through line 28 and through line 42 to high pressure pump 32, from which it flows through line 44 and check valve 46 into high pressure tank 36. These two low pressure tanks 26 thus supply the air to the high pressure pump 32 by means of line 42 and initially only to the pressure tank 36 by line 77.

As air is drawn from the high pressure tank 36 to the intake manifold 37, the pressure decreases in the high pressure tank 36. As shown, the compressor 34 is powered by a 36 volt electric motor 94 and when the pressure in the high pressure tank 36 is used up down to 25 p.s.i., the pressure switch 30 will energize the electric motor 94 starting the main air compressor 34. A dash board switch 93 (FIG. 7) is cut on to start the high pressure pump 32 to build up the pressure from 150 to above 500 p.s.i. as previously explained. As the accelerator 88 (FIG. 1) is depressed, it will open the accelerator valve 92 to increase the speed of the engine.

The 37 amp alternator 96 (FIG. 7) will recharge the 12 volt battery 86 which operates the solenoid valves, switches, lights, etc. The 65 amp alternator 98 recharges the 36 volt battery packs which are the source of energy for the 36 volt electric motors.

A relay switch 102 is positioned between the two 36 volt battery packs 100 and when one battery pack is 90% uncharged, the relay switch 102 will switch to the other while the 65 amp alternator 98 recharges the first one. Six volt batteries are employed to make up the battery packs 100 and they are provided with a 115 volt battery charger which can be plugged into any wall socket.

It is to be understood that the form of my invention herewith shown and described is to be taken as a preferred example of the same and that various changes in the shape, size and arrangements of parts may be resorted to without departure from the spirit of the invention or the scope of the subjoined claims.

What is claimed is:

1. A noxious exhaust-gas-free compressed air power plant for vehicles comprising, in combination, a piston and cylinder type engine having a drive shaft; manifold means for admitting equally highly compressed air to and discharging it from each of the cylinders of said engine to effect reciprocation of the pistons and rotation of the shaft; low and high pressure compressed air tanks; a battery powered compressor for compressing air and delivering it to said tanks; and a battery powered high pressure pump manually actuatable upon a drop in pressure in said high pressure tank to further compress air from said low pressure tank, and deliver it to said high pressure tank for delivery to said engine manifold means.

2. The combination recited in claim 1 wherein said compressor and said pump are driven by electric motors.

3. The combination recited in claim 2 wherein power for said motors is furnished by rechargeable batteries.

4. The combination recited in claim 1 wherein said admitting and discharging means comprise solenoid operated valves.

5. The combination recited in claim 4 wherein said valves are timed to admit compressed air to one cylinder of said engine while discharging compressed air from an adjacent cylinder.

6. The combination recited in claim 1 wherein said discharged compressed air is received in an exhaust tank, and a high pressure exhaust pump delivers said discharged air from said exhaust tank to said high pressure tank.

7. The combination recited in claim 1 wherein an accelerator pedal operated valve controls the flow of high pressure compressed air from said high pressure tank to said engine.

8. The combination with a vehicle having a piston and cylinder type engine operable by compressed air; of at least one low pressure tank and one high pressure tank; first means manually and then automatically operable for compressing air in said low pressure tank to a given pressure; second manually actuated means for raising said given pressure and delivering said air to said high pressure tank; individual automatically and manually actuated means for turning off and on said first means and manually actuated means for turning off and on said second means when said given pressures

are reached or lowered through use of the compressed air by said engine; and manifold means for delivering equally high pressured air to each of said pistons in said cylinders and exhausting it therefrom to effect reciprocation thereof and rotation of the drive shaft and wheels of the vehicle.

9. The combination with a vehicle having a piston and cylinder type internal combustion engine converted to operation by compressed air; of a plurality of compressed air storage tanks mounted on the chassis of the vehicle; plural compressor means for compressing air and delivering it to said tanks; and manual means for energizing at least one of said compressors upon a drop in pressure in said tanks to ensure the manifold delivery of equally highly compressed air to each of the pistons of said engine to effect rotation of the drive shaft and wheels of the vehicle.

* * * * *

United States Patent [19]

Ford, Jr.

[11] **3,987,633**

[45] **Oct. 26, 1976**

[54] **PRESSURIZED GAS OPERATED ENGINE**

[76] Inventor: **Sanders Ford, Jr.**, 1309 S. 58th St., Richmond, Calif. 94804

[22] Filed: **Apr. 19, 1974**

[21] Appl. No.: **462,217**

[52] **U.S. Cl.** **60/671**
[51] **Int. Cl.**[2] **F01K 25/10**
[58] **Field of Search** 123/1; 60/651, 671; 180/66, 67; 137/625.11, 625.15; 251/209

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Primary Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—William W. Haefliger

[57] **ABSTRACT**

High pressure gas distribution apparatus is connected with an engine cylinder to drive a piston therein, and comprises

a. a body containing a high pressure gas inlet and an outlet port,
b. a rotor rotatable in the body to control metering of gas from said inlet to said outlet port
c. the rotor having a connection to be driven by the engine in timed relation to motion of the piston.

1 Claim, 12 Drawing Figures

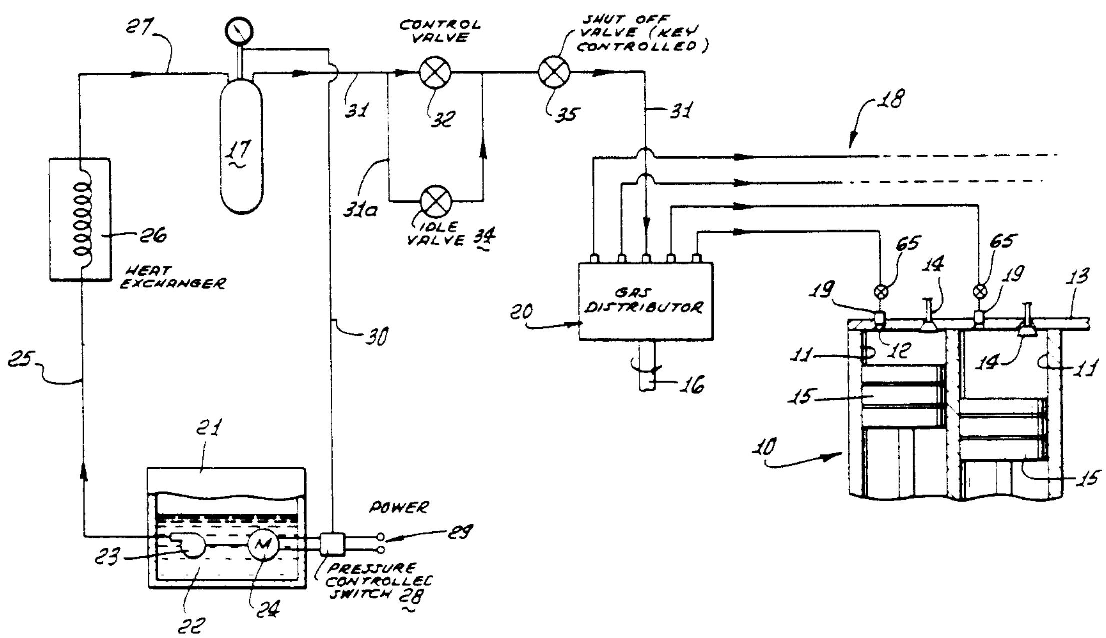


FIG. 1.

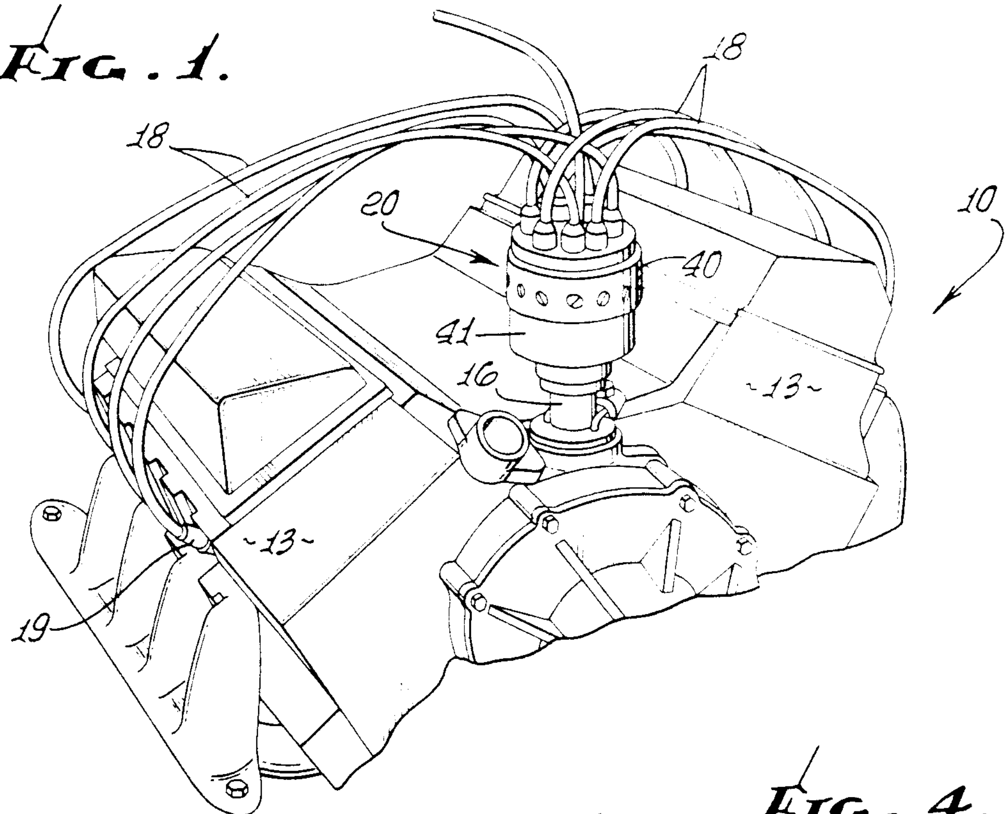


FIG. 4.

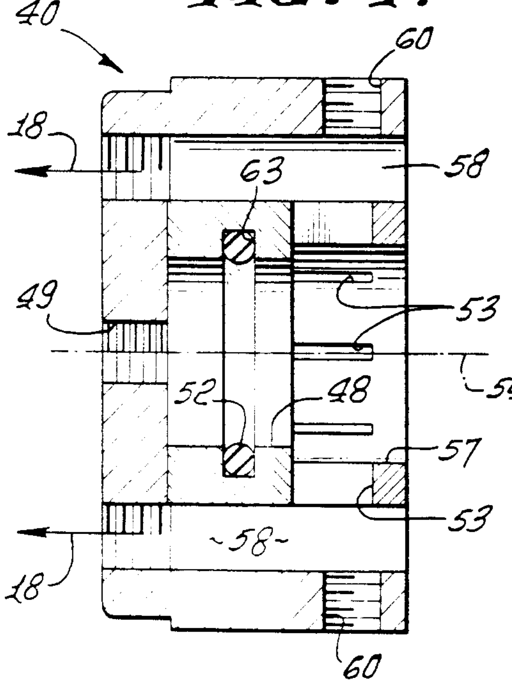


FIG. 3.

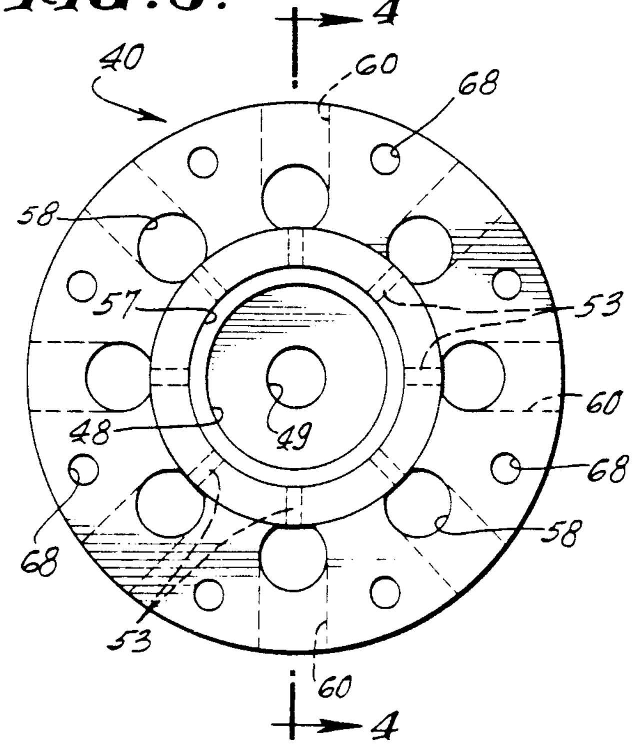


FIG. 2.

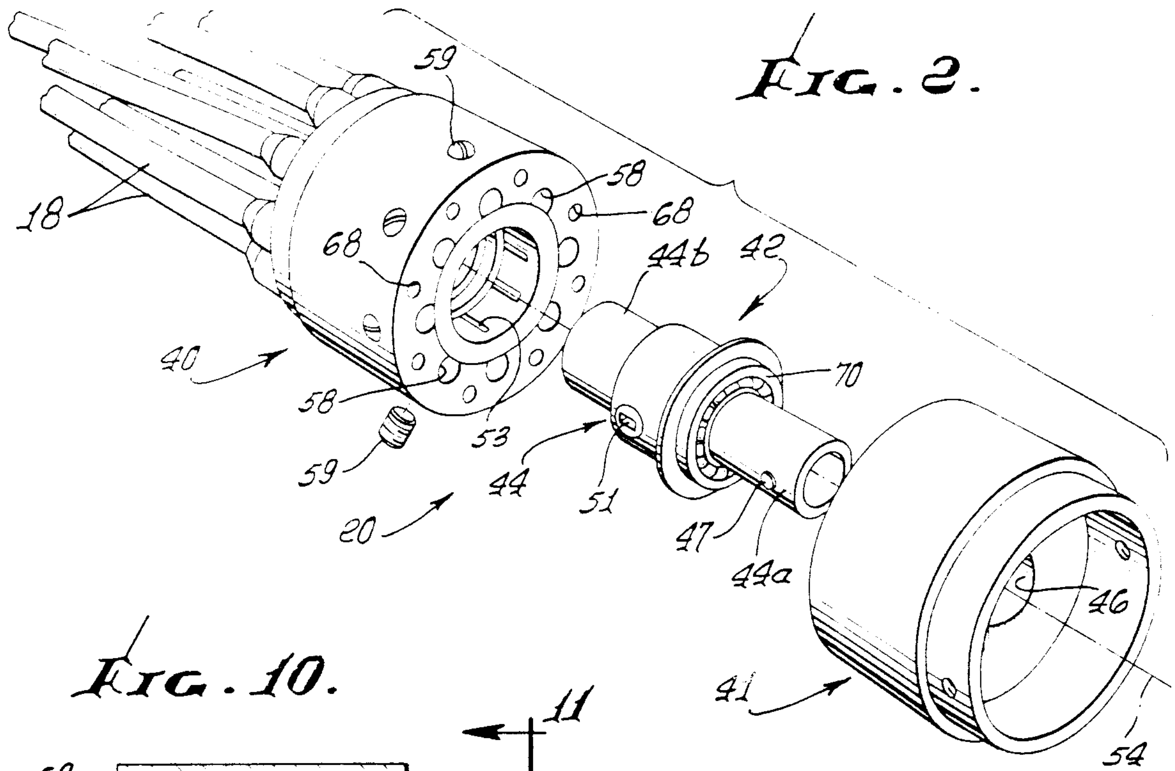


FIG. 10.

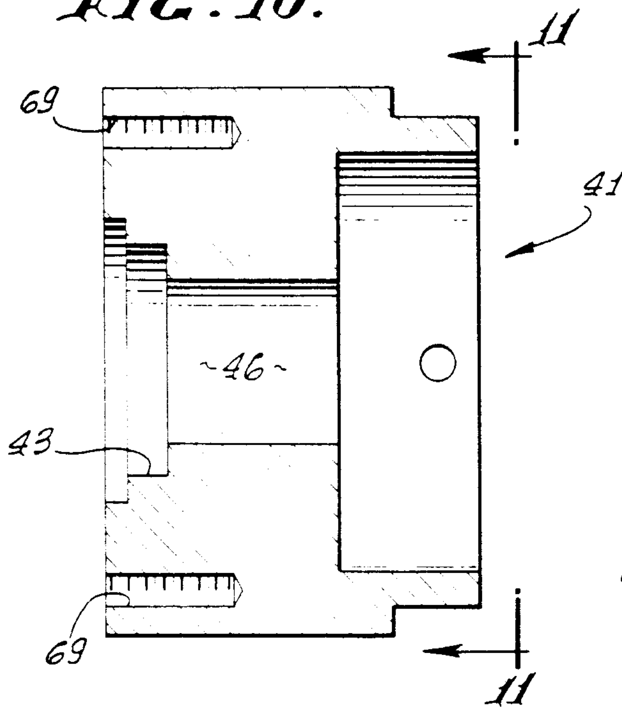


FIG. 11.

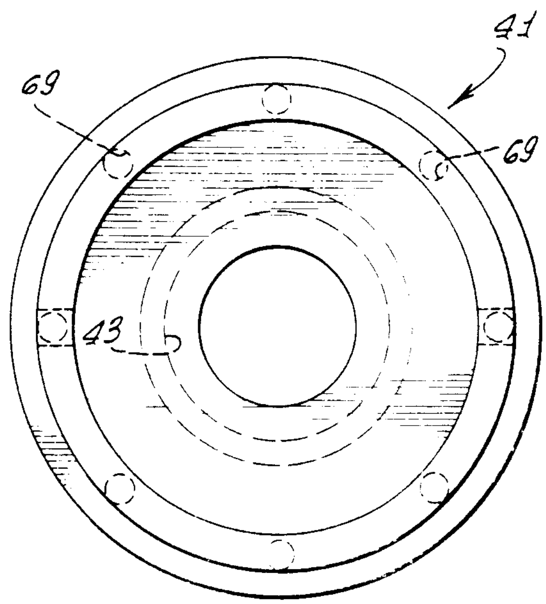


FIG. 7.

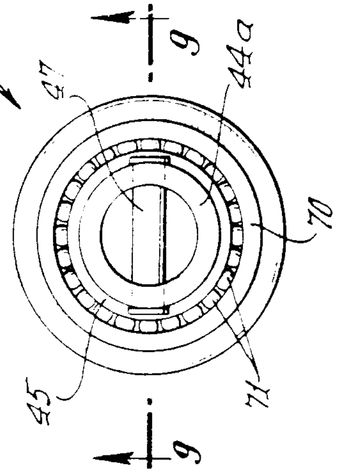


FIG. 5.

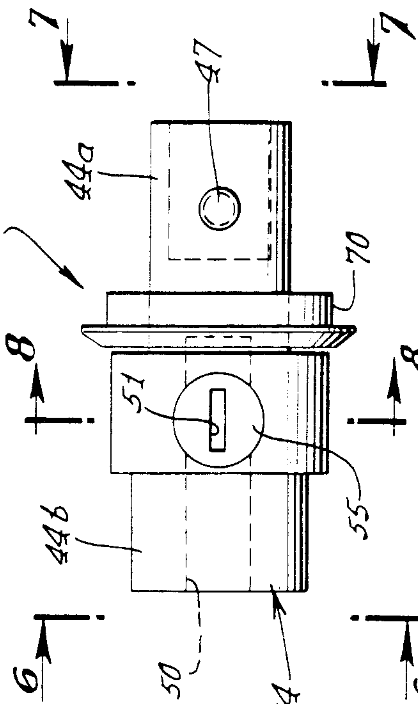


FIG. 9.

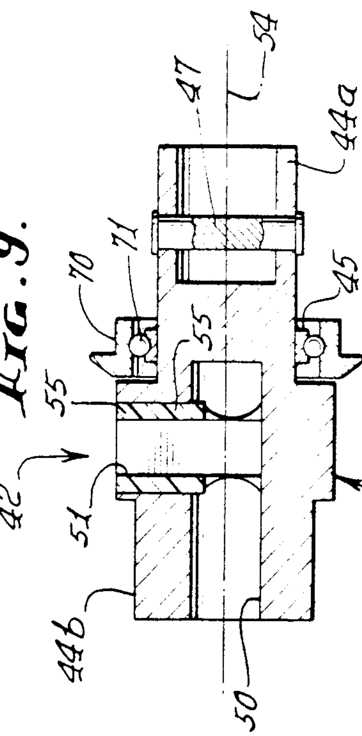


FIG. 6.

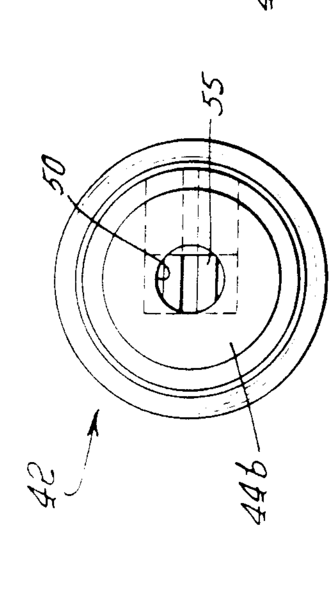


FIG. 8.

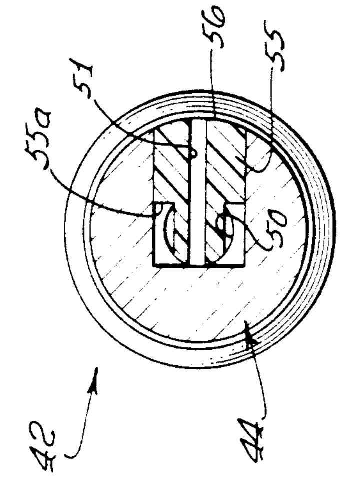
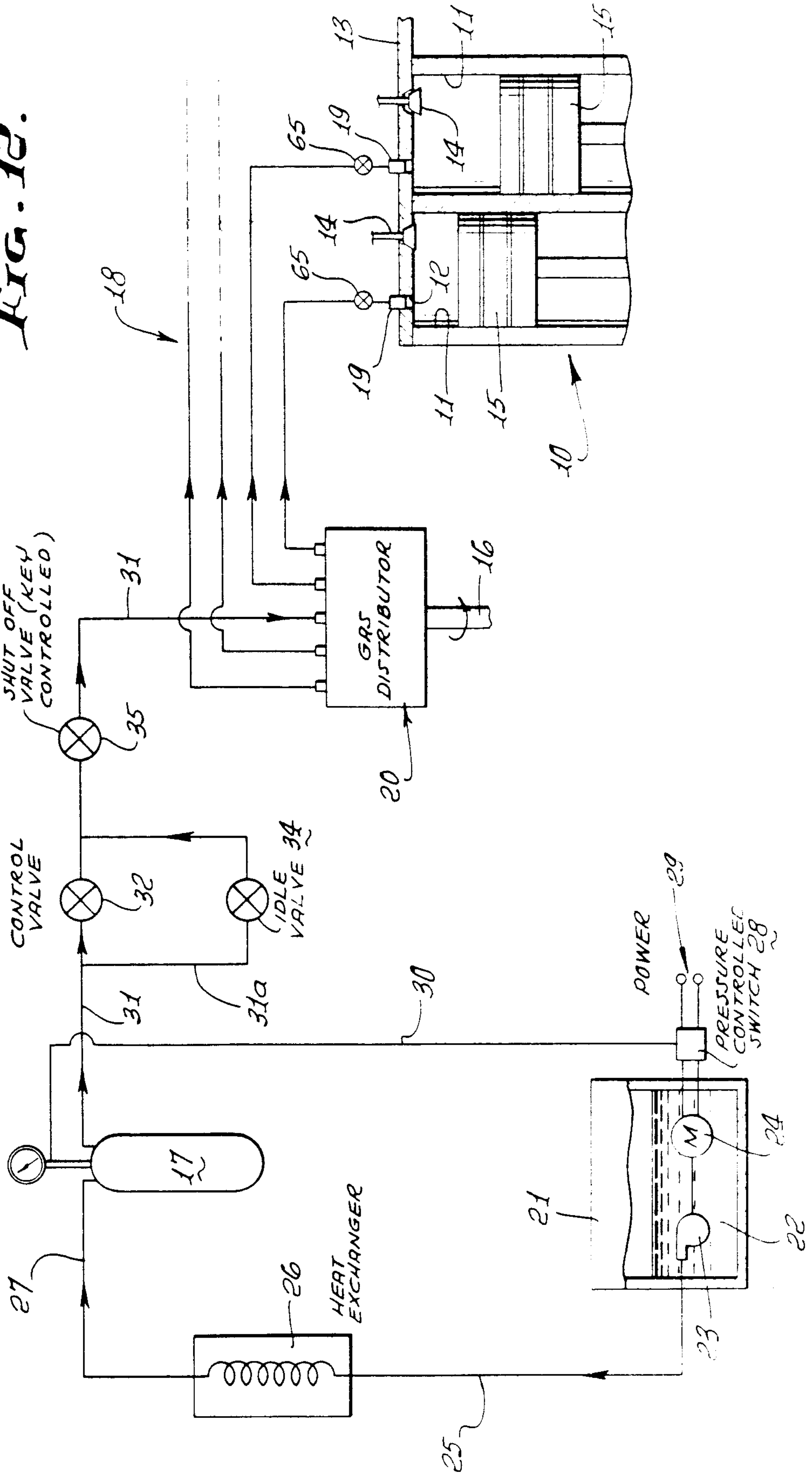


FIG. 12.


SHUT OFF VALVE (KEY CONTROLLED)
CONTROL VALVE
IDLE VALVE
GAS DISTRIBUTOR
POWER
PRESSURE CONTROLLED SWITCH
HEAT EXCHANGER

PRESSURIZED GAS OPERATED ENGINE

BACKGROUND OF THE INVENTION

This invention relates generally to engines, and more particularly concerns a non-combustible gas pressure driven engine of unusually advantageous construction and operation.

There is a great need for development of engines characterized as non-polluting, and which are simple, efficient, and no more expensive to operate than present day gasoline or Diesel engines. There is also a great need for means to convert existing internal combustion engines to non-polluting operation, to save the vast cost of replacement of such engines; however it has been thought that great problems stand in the way of such conversion.

SUMMARY OF THE INVENTION

It is a major object of the invention to meet the above needs and to overcome the conversion problems, in a simple and effective manner. Basically, the invention enables operation of reciprocating piston engines through supply of high pressure non-combustible gas to the engine cylinders in timed relation to engine speed, and in a novel manner, as will be seen. Regarding system aspects, the invention has unusally advantageous application to an internal combustion engine having spark plug openings, valves, pistons, and a spark distributor rotor driven by the engine, the system including:

a. a source of relatively high pressure gas,

b. gas pressure lines connected with the cylinders via said spark plug openings, and

c. distribution means operatively connected with said rotor to be driven thereby for controlling distribution of said high pressure gas from said source via said lines to said cylinders for urging the pistons in power stroke directions in the cylinders.

As will be seen, the source may comprise liquified gas such as nitrogen which, when exhausted, returns to the atmosphere from which it was derived, without pollution effect. Suitable control valving may control the flow of such gas from a container to the distribution means as described, to control engine torgue and speed; and check valves in the lines near the cylinders may pass the gas flow to the cylinders only when sufficient pressure is developed in the lines, as controlled by the distribution means. The latter may advantageously include a body containing a high pressure gas inlet and an outlet part; a rotor rotatable in the body to control metering of gas from the inlet to the outlet, and a connection on the rotor to be driven by the engine in timed relation to piston reciprocation, as will be seen.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following description and drawings, in which:

DRAWING DESCRIPTION

FIG. **1** is a perspective view of an automobile engine incorporating the invention;

FIG. **2** is an exploded view of a valving apparatus;

FIG. **3** is an end view of a valve body section shown in FIG. **2**;

FIG. **4** is a section on lines **4—4** of FIG. **3**;

FIG. **5** is a side elevation of a rotor shown in FIG. **2**;

FIG. **6** is an end view on lines **6—6** of FIG. **5**.

FIG. **7** is an end view on lines **7—7** of FIG. **5**;

FIG. **8** is a section on lines **8—8** of FIG. **5**;

FIG. **9** is a section on lines **9—9** of FIG. **7**;

FIG. **10** is a section through another body section seen in FIG. **2**; and

FIG. **11** is an end view on lines **11—11** of FIG. **10**; and

FIG. **12** is a diagramatic showing of a system incorporating the invention.

DETAILED DESCRIPTION

Referring to FIGS. **1** and **12**, the internal combustion engine **10** to be converted to liquid nitrogen or other gas operation has multiple cylinders **11** with associated spark plug openings **12** in a head **13**. The engine also includes exhaust valves **14**, pistons **15**, and a spark distributor rotor **16** driven by the engine.

In accordance with the invention, a source of relatively high pressure gas such as nitrogen is provided, as for example may include bottle **17**; also, multiple gas pressure lines are connected with the cylinders **11** via the spark plug openings **12**, the plugs having been removed. Typical gas lines **18** are shown, with end fittings **19** threaded into the spark plug openings.

Distribution means **20** is operatively connected with the rotor to be driven thereby for controlling distribution of the high pressure gas from the source in the lines **18** to the cylinders **11** for urging the pistons in power stroke directions in the cylinders. In this regard, advantage is taken of the timing of the rotor **16** (which previously controlled transmission of ignition sparks to the spark plugs), for controlling pressure application to the pistons just after they have passed top dead center in their reciprocation. Typically, the gas pressure supplied to the pistons will exceed 2,000 psi, and such supply will be momentary only, i.e. the means **20** will gate the flow of high pressure gas to a cylinder during only a few degrees of rotor rotation, such pressure will drive the piston downwardly in the cylinder, as the limited quantity of admitted gas expands to a lower pressure in the cylinder, and the exhaust valve **14** will open as controlled by the cam shaft driven by the engine to exhaust the spent gas on the piston upstroke.

Referring to FIG. **12**, the gas source may also be considered to include a reservoir **21** for liquified gas such as nitrogen **22**, the reservoir being appropriately thermally insulated. A pump **23** in the container is intermittently driven by a motor **24** to pump the liquid **22** via line **25** to a heat exchanger **26** for evaporation and flow via line **27** to the container **17**. A control means, such as a pressure controlled switch **28** is operatively connected with the motor (as via the power input lines **29**), and also with the container **17** (as via pressure line **30**), to effect motor and pump operation in response to predetermined gas pressure reduction in the container **17**, for resupplying the container.

A supply duct **31** communicates between the container **17** and the distribution means **20**, and a control valve **32** is connected in that duct to control the rate of flow of high pressure gas to the means **20**, thereby to control energization (torque development) of the engine. Valve **32** may be connected with the accelerator pedal in an automobile, for example. A by-pass line **31***a* extends around valve **32**, and an idle valve **34** is connected in line **31***a*. Valve **34** is always open sufficiently to effect idle or slow speed operation of the engine. An ON-OFF valve **35** in line **31** may be ignition-key operated to turn ON when engine operation is desired.

Referring now to FIGS. 2–11, the distribution means **20** may advantageously include body sections **40** and **41**, and a rotor assembly **42**. Section **41** contains a counterbore **43** to receive bearing race **70** associated with the assembly **42**. The latter also includes a rotor **44** carrying an inner race **45**, there being bearing balls **71** between the two races. Rotor **44** extends at **44***a* within bore **46** in section **41** to couple to the drive rotor **16**, as via a pin **47**.

Rotor **44** includes tubular extent **44***b* received in a bore **48** in body section **40** whereby high pressure gas entering the section **40** via inlet **49** may pass into the bore **50** of the rotor tubular extent for distribution via rotating outlet **51**. Note the O-ring seal **52** retained in groove **63** in body section **40** to seal off against the outer surface of the rotor extent **44***b* and block escape of gas. As outlet **51** successively passes in registration with the circumferentially spaced outlet ports **53** in the body section **40**, high pressure gas is metered to those ports, for time intervals which decrease as the engine speed increases. Slot-like ports **53** and outlet **51** have similar narrow rectangular cross-sections, in cylindrical planes about the axis **54**, for accurate metering. Outlet **51** may be formed by a TEFLON or other plastic plunger-insert **55**, as seen in FIGS. **8** and **9**, that insert having a curved outer surface at **56** to seal against the bore **57** during rotation. Gas pressure is exerted at inner surface **55***a* of the insert to urge it outwardly to seal, as described. Outlets **53** communicate with pressure lines **18** via transfer ports **58**, as shown in FIG. **4**. Clean-out or inspection plugs **59**, as seen in FIG. **2**, are removably received in drilled and threaded side ports **60**, seen in FIG. **4**.

Referring again to FIG. **12**, the lines **18** contain check valves **65** near the engine which operate to pass the flow of high pressure gas to the cylinders only when the pressure in the lines **18** upstream of the valves exceeds predetermined levels as controlled by the distribution means. Accordingly, gas is supplied to a piston only when there is sufficient gas pressure in associated line **18** to drive the piston, as required.

In FIGS. **2–11**, bolts are receivable in body section openings **68** and **69**, to hold the assembly together.

Other gases, such as air, may be used to operate the engine. Also, the engine may be of rotary type, such as a Wankel engine.

I claim:

1. In an engine having chamber structure including a head and reciprocating piston means movable in said chamber structure, said structure having associated inlet porting and valving in the head, and a rotor driven by the engine, the combination comprising:

a. a source of relatively high pressure gas

b. gas pressure ducting connected with said chamber structure via said porting, and

c. distribution means operatively connected with said rotor to be driven thereby for controlling distribution of said high pressure gas from said ducting to said porting for urging the piston means in a power stroke direction in the chamber structure,

d. said source including a resevoir for storing a supply of said gas in its liquified state, a heat exchanger for transforming said liquified gas into a high pressure gas, a container for receiving and storing said high pressure gas subsequent to the heating of the liquified gas in said heat exchanger, duct means connecting the reservoir, the heat exchanger and container for serial flow of fluid therethrough

e. said source means further including a pump means for delivering the liquified gas from the reservoir to the heat exchanger and the to the container, said pump means being energized by a pressure responsive means, said pressure responsive means being responsive to the pressure in said container, whereby said pump is energized upon a predetermined drop in gas pressure within said container to deliver liquified gas from the reservoir, to the heat exchanger and then to said container,

f. a duct communication between the container and said distribution controlling means, and a first control valve connected in series with said duct to variably control the flow of said high pressure gas to said distribution means, a second nonvariable valve in parallel flow relationship to said first control valve, said second valve providing a constant flow rate therethrough.

g. said distribution means including a housing having a single inlet, and multiple outlets communicating with said ducting in the form of multiple ducts, a gas distributor rotor axially rotatable in the housing by the engine driven rotor, the gas distributor rotor controlling flow of high pressure gas from said single inlet to said multiple outlets, said outlets formed as slots which are spaced about the rotor and are relatively narrow in the rotary direction of rotor rotation, said outlet slots formed in said housing, the distribution rotor having a single rotating gas distributing outlet formed as a slot which has successive registration with said outlet slots as the rotor rotates, said outlet slots elongated in a direction generally parallel to the rotor axis, said narrow and elongated outlet slots being generally rectangular and

h. check valve means in said ducting to pass the flow of said high pressure gas from said distribution means to said chamber structure only when the gas pressure in said ducting exceeds predetermined level as controlled by operation of said distribution means.

* * * * *

for CARS – TRUCKS – BOATS – AIRCRAFT – STATIONARY and PORTABLE EQUIPMENT
CONTINUOUS PROPULSION on the SAME TANK of AIR

JOSEPH P. TROYAN
INVENTOR

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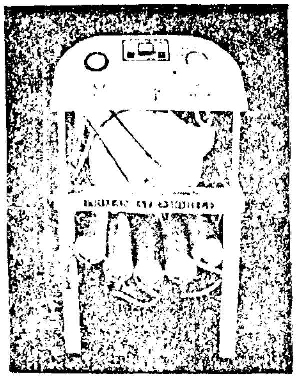
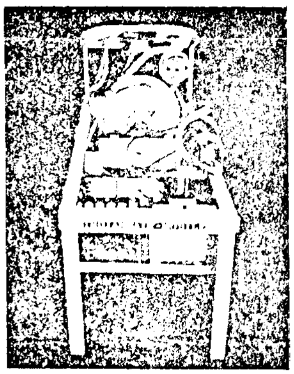
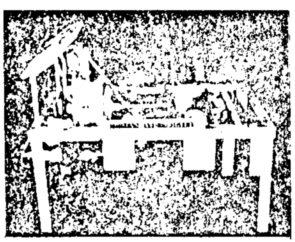
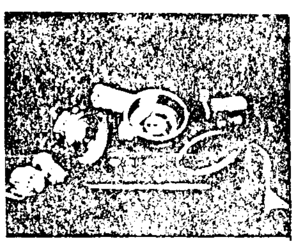
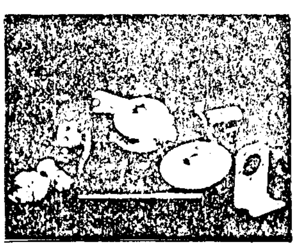
Santa Monica, CA 90404 Bldg. #25

(213) 828-83

TROJAN-AIR-MOBILE
HERMETICALLY SEALED AIR PROPULSION
RECORDED IN U.S. PATENT OFFICE #040011

PATENT PENDING

REPRINTED FROM:
THE STAR-MARCH 16, 1976 PAGE 14

Revolutionary car runs on hot air!

AUTO pollution and gas shortages could soon be a thing of the past with a revolutionary new engine that runs on air.

The $1,000 engine could power cars, trucks, boats and even airplanes, according to its inventor Joseph P. Troyan. He has recorded the device - which he calls the Trojan Air Mobile Engine - with the U.S. Patent Office.

"My engine simply uses Nature's most powerful force: Air pressure," Troyan told the Star.

The silent powerplant uses the force of compressed air heated by electrodes and shot through jets to spin a turbine flywheel.

Troyan got the idea eight years ago, inspired by the tremendous force of hurricanes and tornadoes generated by differences in air temperature.

NO COMBUSTION ENGINE – NO GAS OR OIL – NO TIMING – NO WATER – NO RADIATOR
NO SPARK PLUGS – NO MUFFLERS – NO ETC. ETC. – NO SMOG
UNBELIEVABLE, BUT TRUE

One of our correspondents saw Joseph Troyan's car at the New Earth Exposition in 1973. Troyan had on display a seven-point list of how his engine worked. My friend copied down three of the seven points, then decided to take pictures instead. The negatives were accidentally destroyed in processing at the lab, so all we have are these three points:

1. a 250 psi tank of air in the back end of the car replacing the gas tank, and a one-way air feed line to a foot throttle controlled air valve

2. air feeding from this valve into a 24 volt electrode heated box expanding the air for greater force

3. the air being discharged from the hot box to a continuous high speed driven thrust pump, thereby feeding the air through a feed shoe into the flywheel ports at an approximate 1200 pound thrust, rotating the flywheel at a very high rpm in one direction

Joseph Troyan is deceased, but his son has the engine, and says it works and is finished. However he doesn't know exactly how it works or why it manages to be self-fueling.

THIS IS THE END OF THE W.F.S.E. PROJECTS.
THE FOLLOWING MATERIAL IS PROVIDED AS
A FREE BONUS TO HELP STIMULATE YOUR
THINKING & PROVIDE SOME MORE DATA..

We do not feel that the ELECTROMATIC MOTOR CAR will be feasible for all modes of power systems. So we would like to expose a system that has been developed by A W F S E MEMBER . It is the TROYAN AIR PROPULSION FLYWHEEL, invented by JOSEPH P. TROYAN (patent pending).

The AIR PROPULSION FLYWHEEL will power many systems. To name a few that our present age in society is in need of: First is a no-fuel stationary system for generating electrical power and there is no limit to the size of generator that it will pull 110 V to a 440 V system.

These generators can be designed as portable plants for new construction or in rural areas where noise and exhaust fumes are considered a hazard due to the fact that this system makes no noise and does not burn any fuel whatsoever.

The cost of running our trucks and buses, averages around 25¢ a mile, with the AIR PROPULSION FLYWHEEL driving an Electro-Hydrolic system it would cost .02¢ a mile for the same operation.

Basically the inventor of the AIR PROPULSION FLYWHEEL is using the same principle as the inventor of the ELECTROMATIC MOTOR CAR, it is a RATIO AMPLIFICATION OF MOTION. The only difference is that one uses the motion of air in a closed system, while the other uses the motion of the vehicle itself.

The following is a breakdown of each component that will be used in a Dock Truck or Pull Motor for warehouses or factory use, or on the docks for unloading ships.

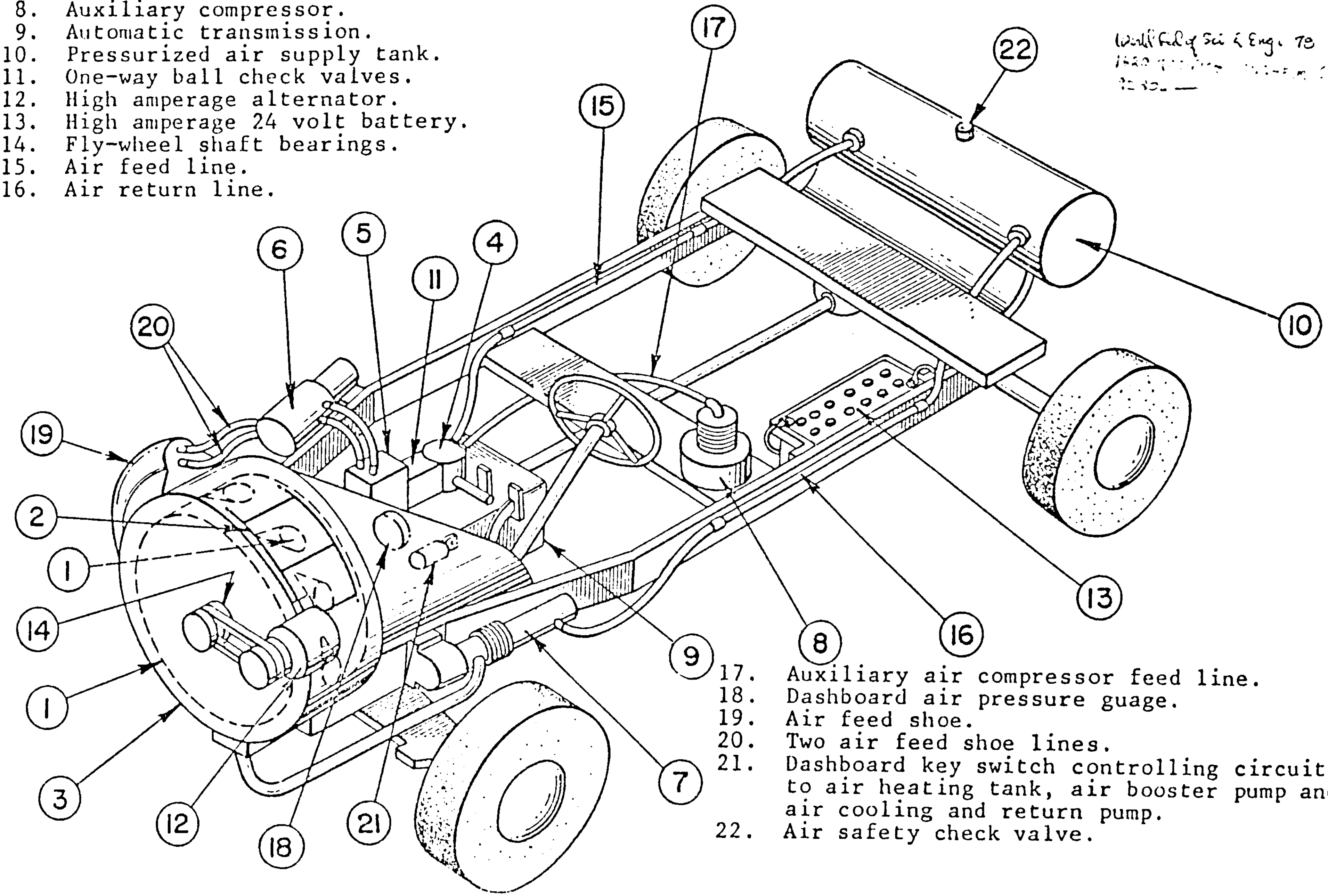
Summary of encompassing features utilized in accordance with the enumerations:

JOSEPH P. TROYAN INVENTOR

REGISTERED U.S. PATENT OFFICE # 040011

TROJAN AIR-MOBILE T.M.

1. Fly-wheel and ports.
2. Fly-wheel port sealing rings.
3. Fly-wheel sealed encasement.
4. Air foot throttle valve.
5. Air heating unit.
6. Air thrust pump.
7. Air return cooling system and pump.
8. Auxiliary compressor.
9. Automatic transmission.
10. Pressurized air supply tank.
11. One-way ball check valves.
12. High amperage alternator.
13. High amperage 24 volt battery.
14. Fly-wheel shaft bearings.
15. Air feed line.
16. Air return line.



17. Auxiliary air compressor feed line.
18. Dashboard air pressure guage.
19. Air feed shoe.
20. Two air feed shoe lines.
21. Dashboard key switch controlling circuits to air heating tank, air booster pump and air cooling and return pump.
22. Air safety check valve.

TROJAN AIR MOBILE

I, Joseph P. Troyan, born in the U.S.A., spent the better part of my life in the Electrical Engineering field, and several other technical fields. In the past seven or eight years I have devoted my knowledge and ability in developing and inventing an air propulsion system for automobiles, boats, aircraft, and every conceivable type of stationary and portable equipment. My invention consists of a fly-wheel propulsion exclusively driven by compressed air, utilizing the same tank of air by a forced return method of the air back into the supply tank.

A more comprehensive and clear description of my invention follows: The fly-wheel bearing cone-type ports in the outer circumference, drilled at an approximate 35° or 40° angle, allowing compressed air to be forced into the ports from an air supply tank thereby creating a high rate of R.P.M., after which time, at a certain given point, the air is sucked back into a high powered pump and charged back into the supply tank.

As a further point of value, to bring about a high P.S.I. charge into the fly-wheel ports, I have conceived and developed an air feed throttle, a small air tank containing high heating elements for the purpose of expanding the original highly pressurized air from the supply or storage tank through the foot-throttle valve into the small heated air tank, henceforth, into a high powered thrust pump creating a very high thrust of air through the feed shoe and fly-wheel encasement into the fly-wheel ports. The air foot throttle valve is so arranged that by compressing the foot throttle, approximately halfway, will feed one fly-wheel port, and when extra power is needed the air throttle valve is then pressed down further in order to feed air through two air lines, thereby feeding two fly-wheel ports at the same time. Each fly-wheel port is sealed by conventional type steel rings in order to maintain each charge of air into each port without any possible back feed of air and permitting the fly-wheel to rotate in one direction without any interference.

At the air discharge point, in the fly-wheel encasement, where the air return pump is attached, the air is returned in a small cooling tank encompassing a number of fins so that the air is properly cooled before it is returned, under pressure, to the pressurized air supply tank.

In addition to the above, I have developed a high powered auxiliary compressor to deliver air through the foot throttle valve, air heating tank, and henceforth, into the fly-wheel for the purpose of emergency requirements only. This auxiliary compressor will kick in and operate only if, for any reason, there should be a loss of pressurized air in the supply tank through accident or unforeseen circumstances causing the loss of said supply tank air.

The auxiliary compressor, the heating elements in the heating tank, the continuous high thrust pump, as well as the air return pump to the supply tank, will be operated by a 24 volt battery which will automatically keep its high amperage charge by a high amperage alternator mounted on the fly-wheel encasement and belt-driven from the fly-wheel shaft pulley.

Joseph P. Troyan

A necessary amount of one-way ball check valves are placed in air lines where needed and an automatic pressure valve shall be installed in the air supply tank.

The transmission consists of a specially designed two-forward and one-reverse automatic unit.

The propulsion fly-wheel shaft is rotated on a close coupled set of bearings encased on each side of the fly-wheel housing or enclosure.

My invention, by all means, represents the most revolutionary development in the propulsion field as compared to internal combustion engines, since there is no gasoline, oil or any other chemical or petroleum products utilized in my propulsion system.

My invention covering my propulsion system has tremendous applications in its utilization for operating cars, trucks, boats, aircraft, stationary and portable equipment, as well as driving electric generators for lighting and heating of homes, as well as electric cooking equipment.

The tremendous number of applications by this inventive feature of propulsion cannot be totally visualized at this time; further, my invention will be totally responsible in eliminating all airborne smog and chemical health hazards, such as created by internal combustion engines.

Summary of encompassing features utilized in my invention and in accordance with the enumerations:

1. Fly-wheel and ports
2. Fly-wheel port sealing rings
3. Fly-wheel sealed encasement
4. Air foot throttle valve
5. Air heating unit
6. Air thrust pump
7. Air return cooling system and pump
8. Auxiliary compressor
9. Automatic transmission
10. Pressurized air supply tank
11. One-way ball check valves
12. High amperage alternator
13. High amperage 24 volt battery
14. Fly-wheel shaft bearings
15. Air feed line
16. Air return line
17. Auxiliary air compressor feed line
18. Dashboard air pressure gauge
19. Air feed shoe
20. Two air feed shoe lines
21. Dashboard key switch controlling circuits to air heating tank, air booster pump and air cooling and return pump
22. Air safety check valve

Witness
Glenn Borland

Joseph P. Troyan
Inventor

Fig. 2.

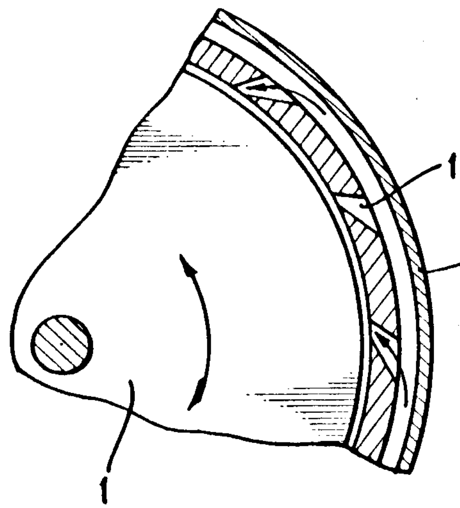


Fig. 1.

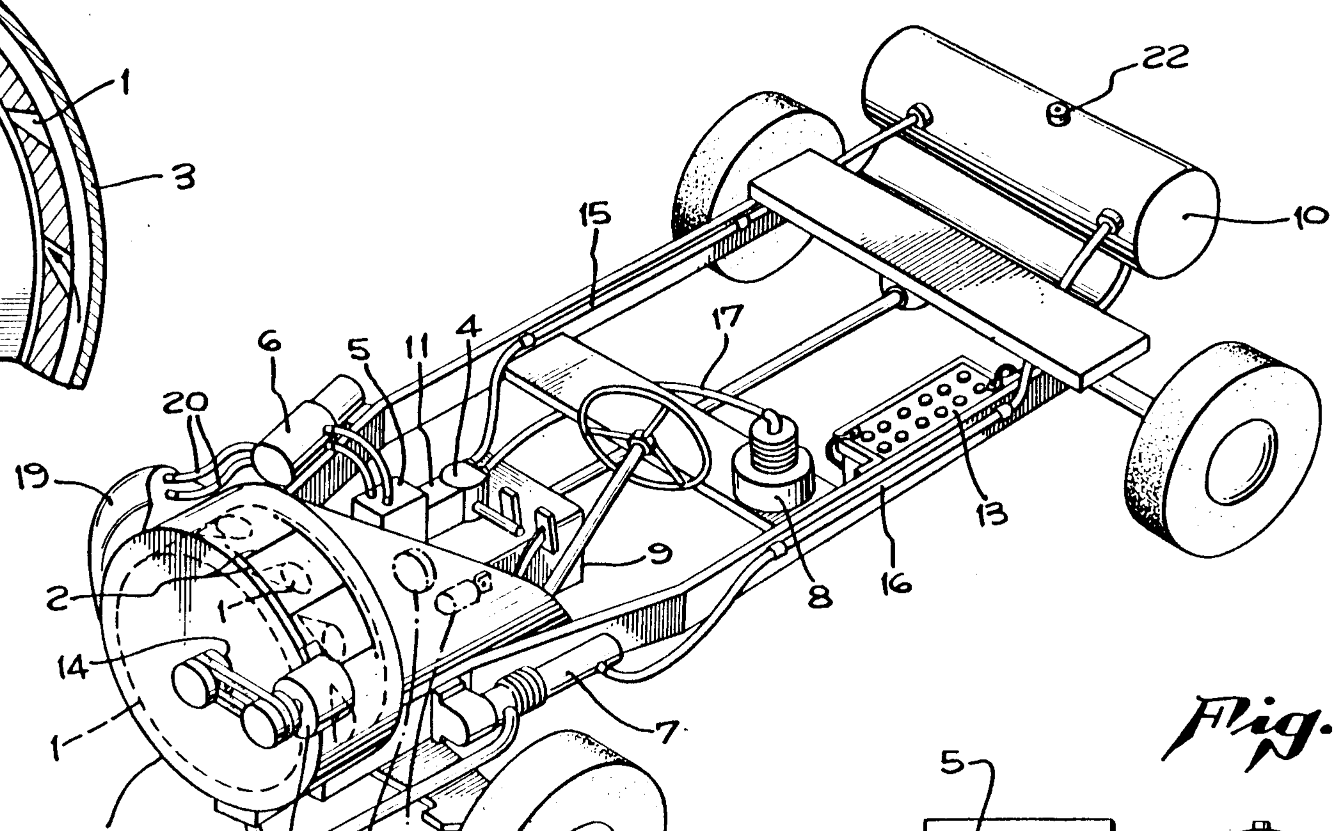
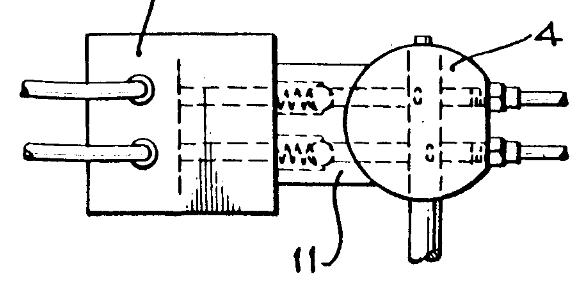


Fig. 3.



TROJAN FLY-WHEEL
AIR PROPULSION

JOSEPH P. TROYAN
INVENTOR

for CARS – TRUCKS – BOATS – AIRCRAFT – STATIONARY and PORTABLE EQUIPMENT
CONTINUOUS PROPULSION on the SAME TANK of AIR

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INVENTOR

2834 Colorado Blvd.
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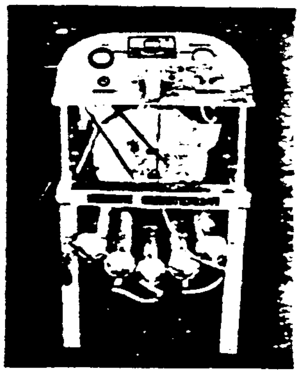
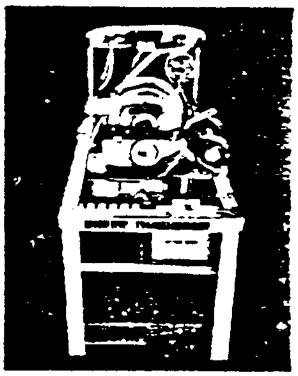
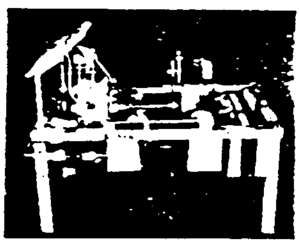
(213) 828-8383

TROJAN-AIR-MOBILE
HERMETICALLY SEALED AIR PROPULSION
RECORDED IN U.S. PATENT OFFICE #040011







THE STORY ON THE TROJAN AIR PROPULSION FLYWHEEL

The Trojan Air Propulsion Flywheel represented in the aluminum cradle, is set-up to drive a 110-volt AC generator for the purpose of lighting and power for every electrical requirement power needed.

My invention will drive any size of generator conceivable for the purpose of light and power in rural areas, boats, motor homes, and all other necessary areas where light and power is required.

There will be a number of different sizes of units produced to meet all requirements conceivable.

J P Troyan

NO COMBUSTION ENGINE – NO GAS OR OIL – NO TIMING – NO WATER – NO RADIATOR
NO SPARK PLUGS – NO MUFFLERS – NO ETC. ETC. – NO SMOG
UNBELIEVABLE, BUT TRUE

for CARS – TRUCKS – BOATS – AIRCRAFT – STATIONARY and PORTABLE EQUIPMENT
CONTINUOUS PROPULSION on the SAME TANK of AIR

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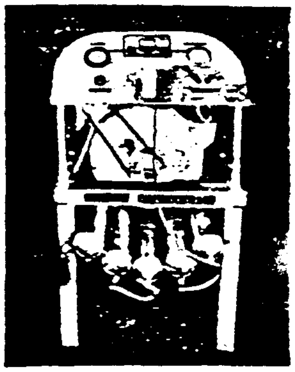
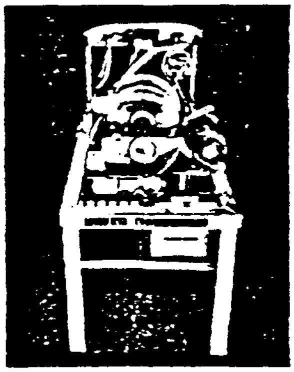
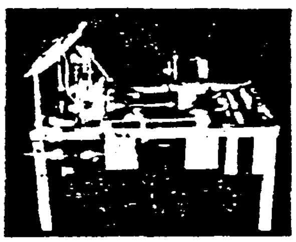
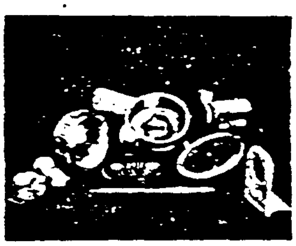
TROJAN-AIR-MOBILE
HERMETICALLY SEALED AIR PROPULSION
RECORDED IN U.S. PATENT OFFICE #040011

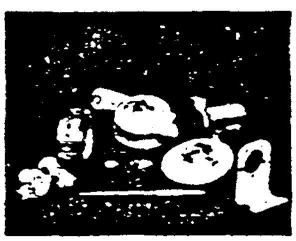
THE STORY AND OPERATING PRINCIPLES OF THE TROJAN FLYWHEEL AIR PROPULSION UNIT











(1) A 250 Lbs. tank of air in the back end of the car replacing the gasoline tank, a one-way air feed line to a foot throttle controlled air valve.

(2) Air feeding from this valve into a 24-volt electrode heated box expanding the air for greater force.

(3) The air being discharged from the hot box to a continuous high speed driven thrust pump, thereby feeding the air through a feed shoe into the flywheel ports at an approximately 2,000 pound thrust rotating the flywheel at a very high RPM in one direction.

(4) If the foot throttle is compressed beyond the one-half way mark the air is fed through the same principle as #3, and now feeding two lines with an equal thrust into two of the flywheel ports delivering twice the amount of flywheel force, or 2,000 pound thrust each into two ports.

(5) The air is consequently released on the opposite side of the flywheel enclosure and sucked in by a cooling pump, driving the air back into the original supply tank.

(6) Should the original supply tank exceed the 250 pound pressure, a relief valve automatically opens to discharge the excess pressure.

(7) If for any reason an air line leak or accident causing such leak should occur, then the auxiliary compressor automatically kicks in supplying additional air to keep the car going.

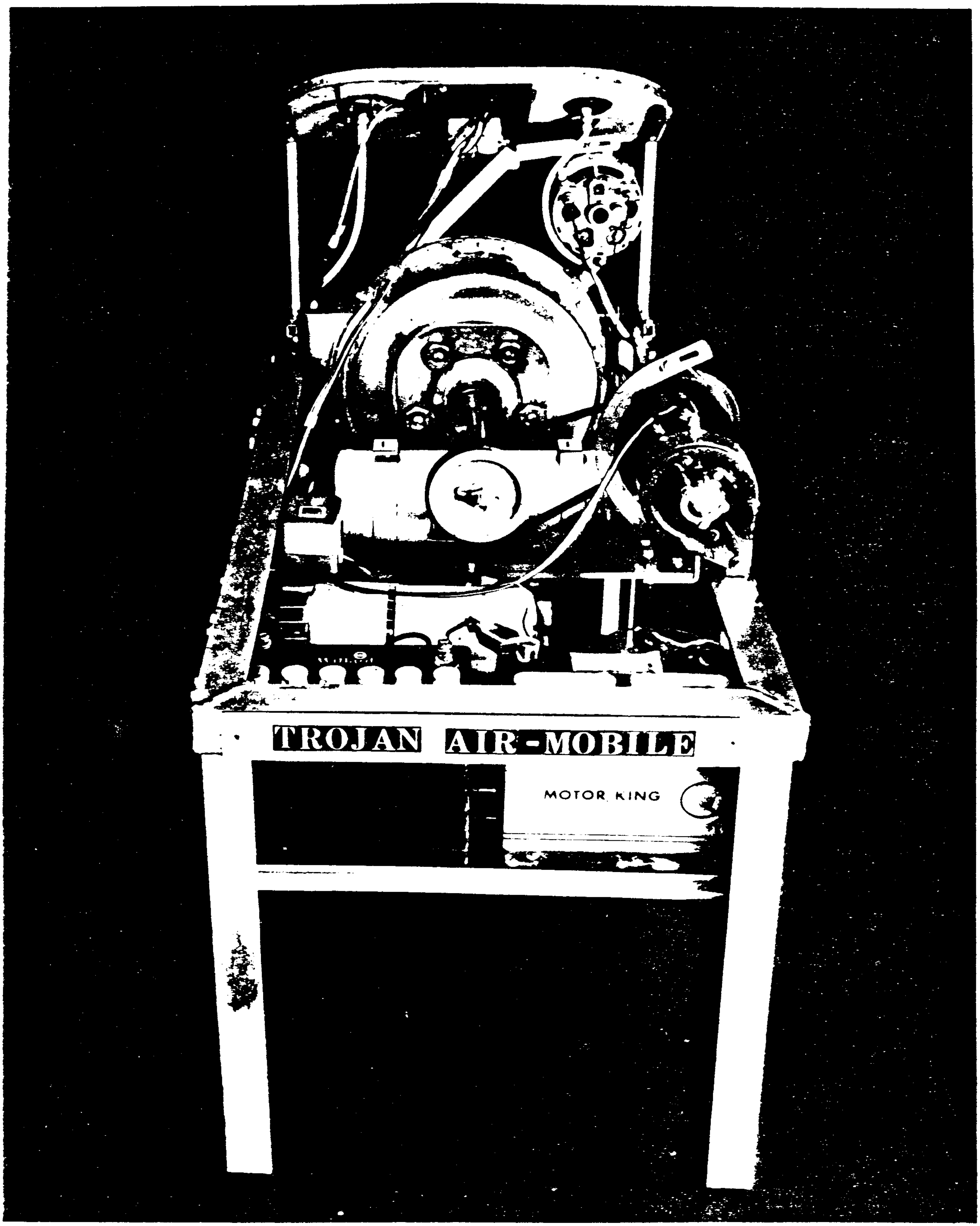
(8) The entire system will be operated off a 24-volt battery and an alternator belt driven from the forward side of the flywheel enclosure operating an 80 amp. alternator charging the 24-volt battery.

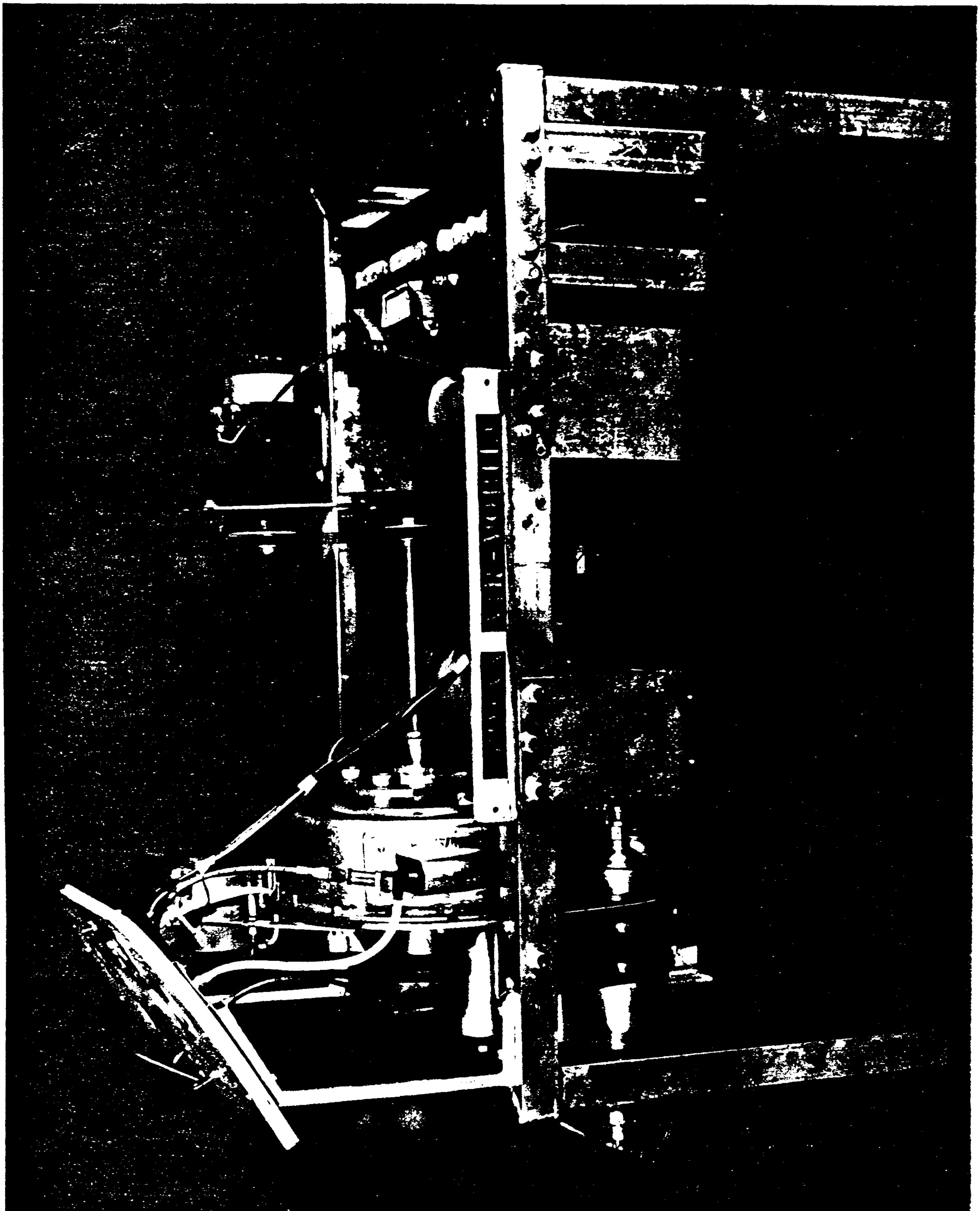
This Flywheel Air Propulsion invention, from all indications seems to be the greatest revolutionary invention and offers service for many years without cost of repairs.

Joseph P. Troyan

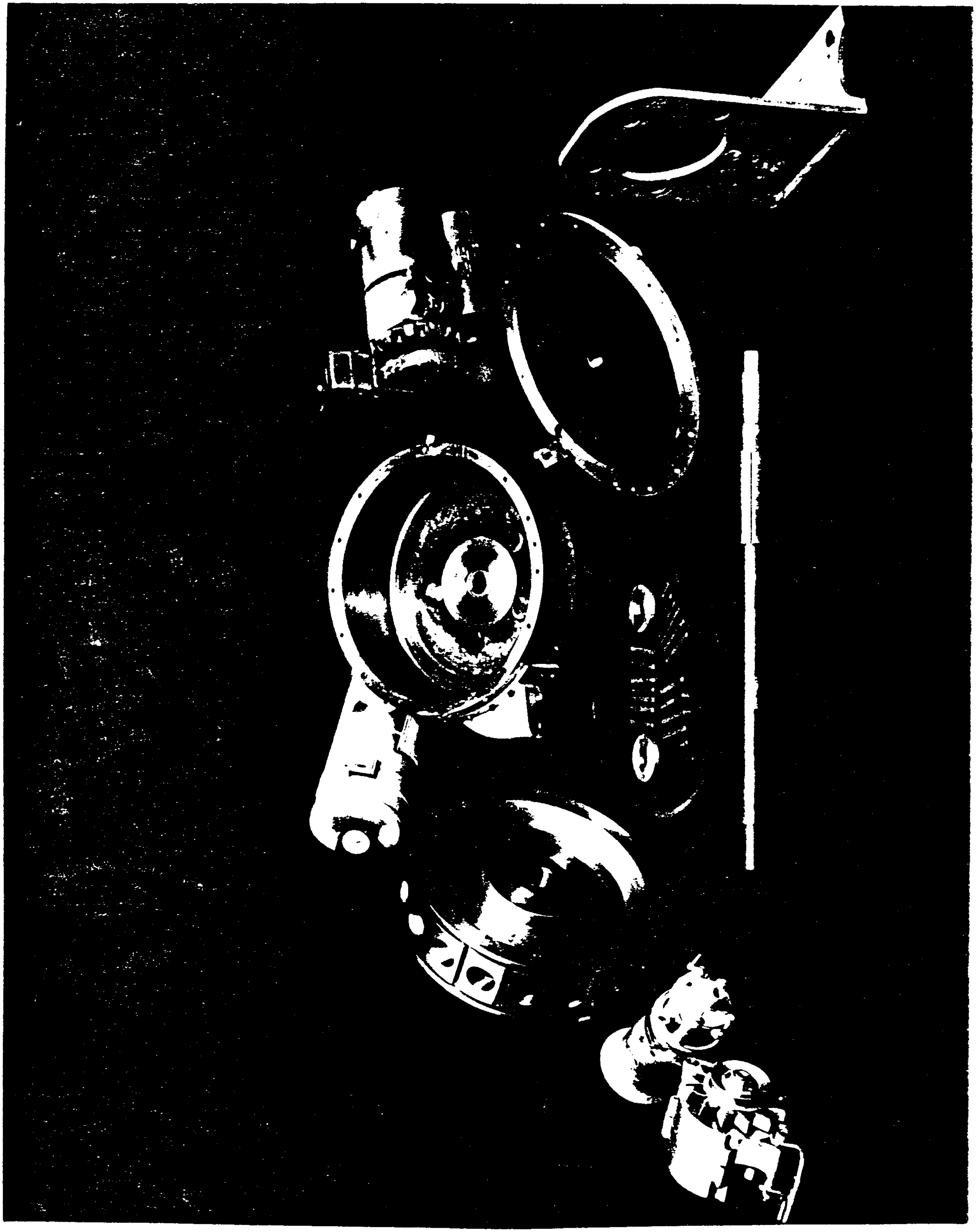
Joseph P. Troyan
Inventor

NO COMBUSTION ENGINE – NO GAS OR OIL – NO TIMING – NO WATER – NO RADIATOR
NO SPARK PLUGS – NO MUFFLERS – NO ETC. ETC. – NO SMOG
UNBELIEVABLE, BUT TRUE


TROJAN AIR-MOBILE
MOTOR KING




ROJAN AIR-MOBILE



United States Patent [19]

Santos

[11] **4,043,126**

[45] **Aug. 23, 1977**

[54] TURBINE ENGINE FOR AUTOMOTIVE VEHICLES

[76] Inventor: **Jaime Rios Santos,** Calle Jose H. Aldrey, 1442, Santiago Iglesias, Rio Piedras, P.R. 00921

[21] Appl. No.: **700,810**

[22] Filed: **June 29, 1976**

[51] **Int. Cl.²** **F15B 13/07**

[52] **U.S. Cl.** .... **60/407;** 60/412; 137/625.11; 180/66 B

[58] **Field of Search** .... 60/407, 412, 416, 425, 60/483, 493; 137/625.11; 180/66 B

[56] **References Cited**

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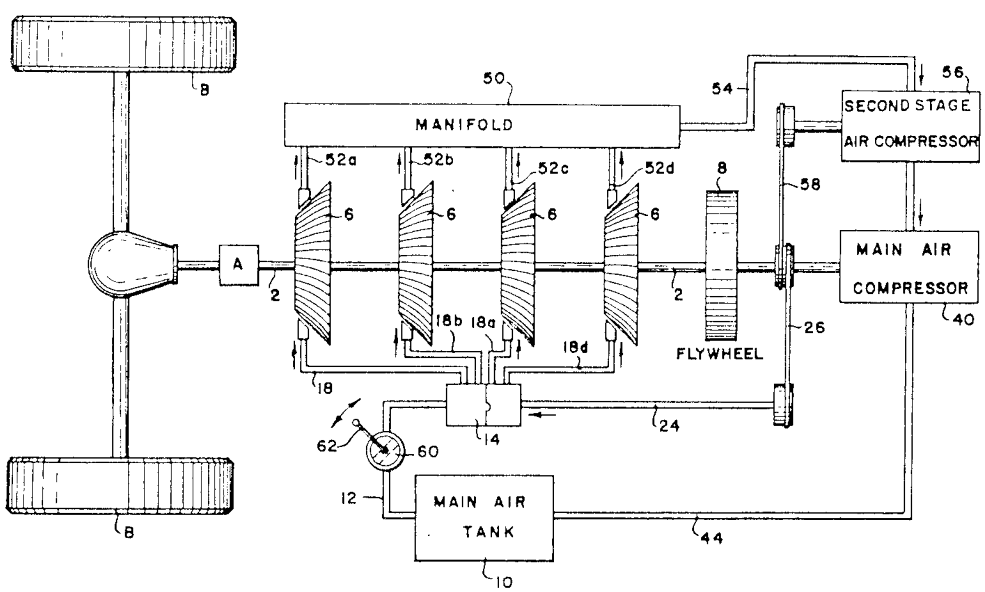
13,936 of	1913	United Kingdom	60/407

Primary Examiner—Edgar W. Geoghegan
Attorney, Agent, or Firm—Scrivener, Parker, Scrivener and Clarke

[57] **ABSTRACT**

An engine for driving an automotive vehicle has a plurality of turbine rotors mounted on the main drive shaft. Compressed air is supplied to the rotors in succession from a distributing valve which is supplied with compressed air from a main air tank, and compressed air at reduced pressure from the delivery side of each rotor is supplied to a manifold which also supplies the main air tank through a second stage compressor.

2 Claims, 4 Drawing Figures



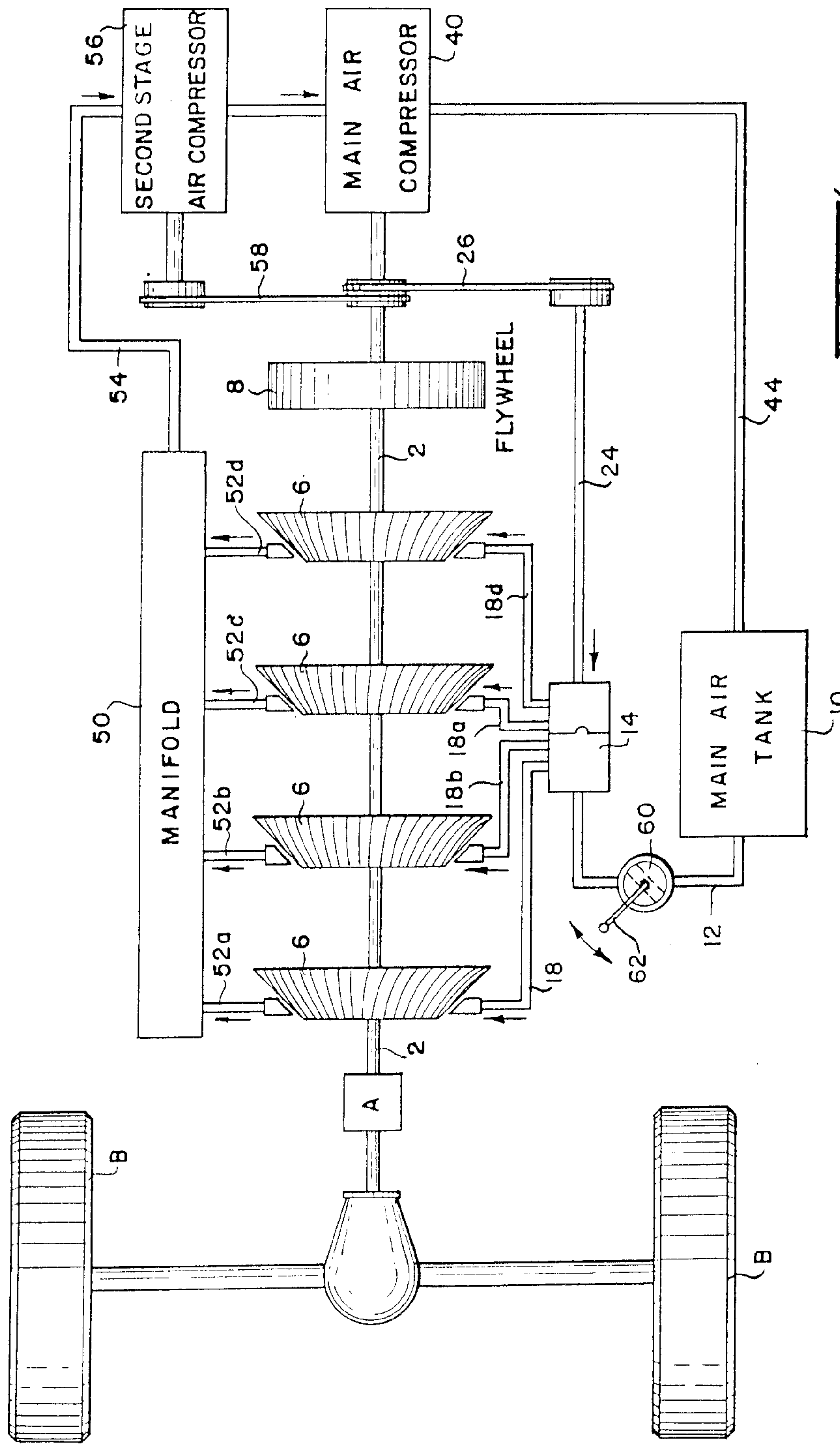

SECOND STAGE AIR COMPRESSOR
MAIN AIR COMPRESSOR
FLYWHEEL
MANIFOLD
MAIN AIR TANK
A
B
56
40
58
26
54
8
2
44
24
6
52d
52c
52b
52a
50
18d
18a
18b
18
14
10
60
62
12

Fig. 1

Fig. 2

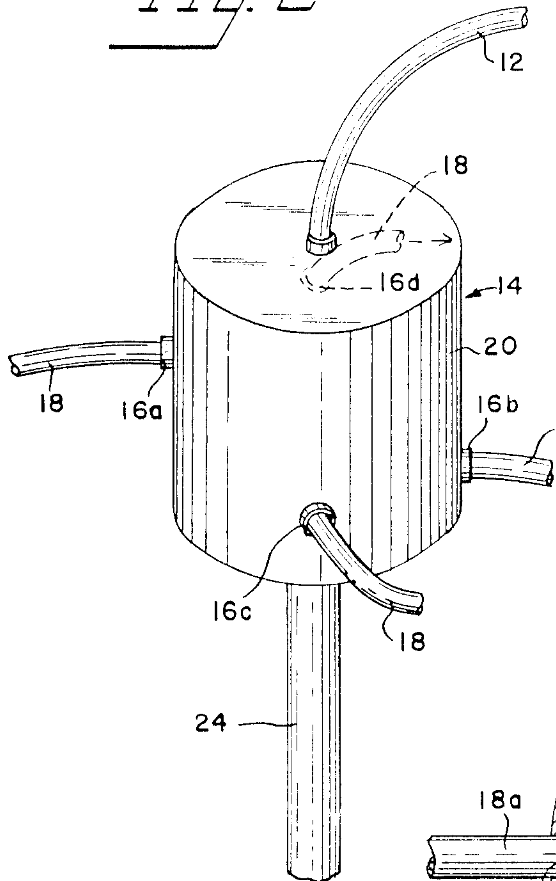
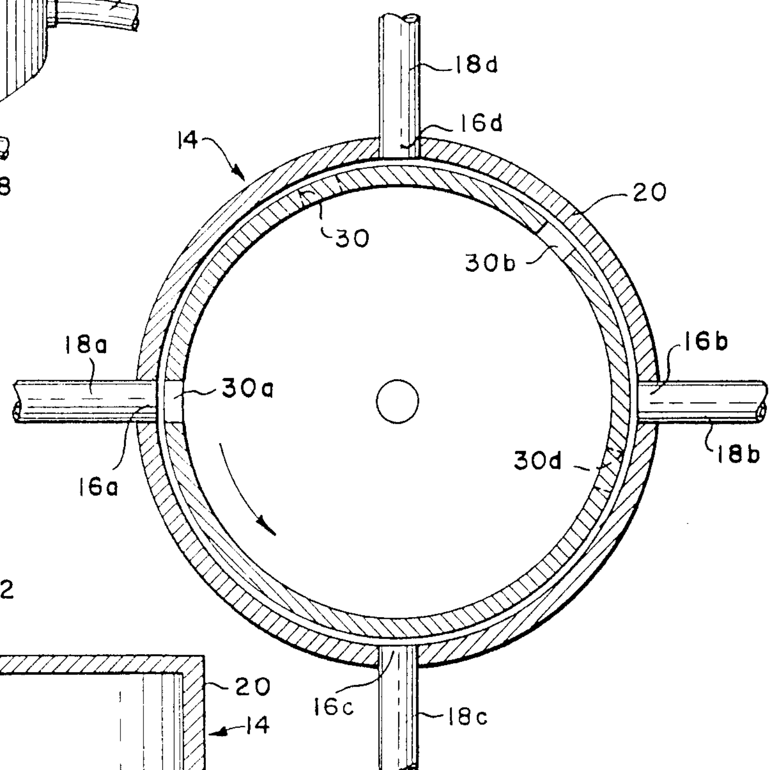


Fig. 4



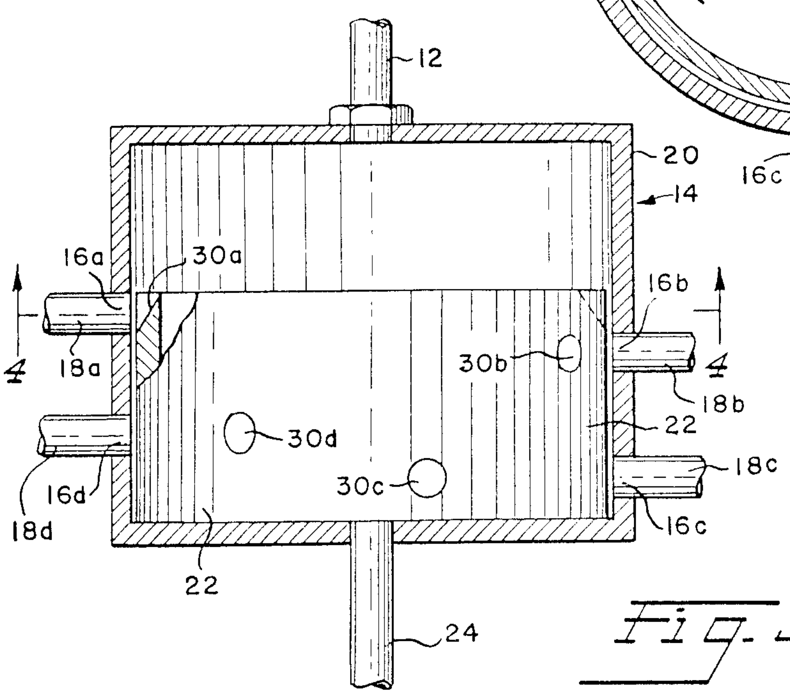


Fig. 3

TURBINE ENGINE FOR AUTOMOTIVE VEHICLES

BACKGROUND OF THE INVENTION

The present day interest in environmental quality, and the statutes requiring reduction in air pollution, make it necessary to provide a means for driving automotive vehicles which can take the place of the internal combustion engine. One possible source of motive power is compressed air and it has been proposed, and is now disclosed in United States Letters Patent, that compressed air be utilized to drive automobile engines. However, most of these proposals have envisioned reciprocating piston engines and these have not been found to be satisfactory for a variety of reasons, the most important of which is the inertia of the moving parts of such engines, which is very great and requires such a high starting torque that such engines have not been successful. Proposals have also been made to utilize the turbine principle for the propulsion of automobile vehicles but these have not been successful for a variety of reasons.

It has therefore been the object of this invention to provide a turbine engine powered by compressed air which will be satisfactory and useful for the propulsion of automobiles and other automotive vehicles.

SUMMARY OF THE INVENTION

The turbine rotors of an automobile engine are mounted on a common main drive shaft and are sequentially supplied with compressed air by a distributor which is itself supplied from a main compressed air tank which, in turn, is supplied by a shaft-driven compressor to which second stage compressed air is delivered from the output sides of the rotors through a manifold.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagramatic view of the turbine engine system according to the invention;

FIG. **2** is a perspective view of the distributor which forms part of the engine;

FIG. **3** is a diametrical sectional view of the distributor, and

FIG. **4** is a sectional view taken on line **4—4** of FIG. **3.**

DESCRIPTION OF THE INVENTION

The turbine engine provided by the invention consists in a suitably mounted rotatable drive shaft **2** which is connected through conventional gearing A to the drive wheels B of an automobile. A plurality of turbine rotors **6** are mounted on the shaft in suitably spaced relation and the entire assembly of shaft and rotors is mounted in an engine block or casing which is conventional and is therefore not illustrated. A fly-wheel **8** is also mounted on the shaft and has its usual function.

Means are provided by the invention for sequentially supplying compressed air to the rotors, and such means comprise a main air tank **10** which forms a reservoir of air under suitable high compression, and which supplies compressed air through pipe **12** to the inlet port of a distributor **14** which is shown in detail in FIGS. **2, 3** and **4.** This distributor is provided with outlet ports **16***a*, **16***b*, **16***c*, **16***d* in the same number as the rotors, and the outlet ports are connected through tubing **18***a*, **18***b*, **18***c*, **18***d* to the drive side of the rotors, there being four rotors in the disclosed embodiment of the invention and therefore four outlet ports in the distributor and four pipe connections from the distributor to the rotors.

The distributor comprises a fixed cylindrical casing **20** to which the compressed air is supplied through pipe **12** from the main air tank, and in the disclosed embodiment the peripheral wall of the casing is provided with the four outlet ports **16***a*, **16***b*, **16***c*, **16***d* each of which is connected to the input or drive side of one of the turbine rotors through one of the pipes **18.** Within the casing there is provided a cup shaped cylindrical rotatable valve member **22** which is mounted on the end of a shaft **24** is rotated by drive connection **26** from the main drive shaft **2.** The cup shaped rotatable valve member is open to the interior of casing **20** and therefore is constantly filled with compressed air, and its wall is provided with openings **30***a*, **30***b*, **30***c*, **30***d* which sequentially register with the outlet ports **16** in the fixed casing member.

In order to provide the sequential supply of compressed air to the shaft rotors the casing ports **16***a*, **16***b*, **16***c* and **16***d* are positioned at progressively spaced positions axially of the casing **20,** and each of the ports **30***a*, **30***b*, **30***c*, **30***d* in the rotatable valve member **22** is positioned at the same axial level as the correspondingly lettered outlet ports in the casing and are spaced circumferentially of the valve member, in the present case by 90° spacing, because there are four rotors **6.**

Means are provided by the invention for supplying compressed air from two sources. The first of these is a main air compressor **40** which is of the rotary type and is driven by direct connection to the main drive shaft and which delivers compressed air directly to the main air storage tank **10** through piping **44.** The second source of compressed air is a manifold **50** which is connected by piping **52***a*, **52***b*, **52***c*, **52***d* to the output side of each of the turbine rotors **6** so that the manifold is sequentially supplied with compressed air at the reduced pressure at the output side of the turbine rotors, whereby a constant air pressure is maintained in the manifold which, in turn, is connected by piping **54** to a second stage rotary air compressor **56** which is driven from the drive shaft **2** through drive connection **58.**

A valve **60** is provided in the piping connection **12** between the main air tank **10** and distributor **14,** and may be operated by means such as the usual accelerator pedal **62** of the automobile for starting the engine and for regulating the supply of compressed air to the distributor, and therefor to the turbine rotors, thereby to regulate the speed of rotation of the drive shaft.

I claim:

1. A turbine engine for an automotive vehicle, comprising a rotatable drive shaft, a plurality of turbine rotors mounted on the shaft, a main compressed air tank, a compressor driven by the drive shaft and connected to supply compressed air to the main air tank, a distributor valve, means for supplying compressed air from the main tank to the distributor valve, connections for transmitting compressed air from the distributor valve to the drive side of each rotor, means operated by the drive shaft for continuously operating the distributor valve to cause compressed air to flow to the rotors in sequence, a manifold, connections between the delivery side of each rotor and the manifold, and a connection for supplying second stage compressed air from the manifold to the main air compressor.

2. A turbine engine according to claim **1,** in which the distributor valve comprises a closed cylindrical casing the interior of which is open to the main air tank, a

plurality of outlet ports in the casing the number of which is equal to that of the rotors and which are spaced axially of the casing, a rotatable cup shaped valve within the casing which is open to the interior of the casing and is connected to be rotated by the drive shaft, the valve cup shaped having a plurality of openings in its wall equal in number to that of the outlet ports in the casing, each of the outlet ports in the casing corresponding in axial position to only one of the openings in the wall of the cup shaped valve member and the ports and openings being spaced circumferentially of the casing and the cup shaped valve member, whereby the ports in the casing are sequentially supplied with compressed air from the interior of the casing.

* * * * *

United States Patent [19]
Murphy

[11] 4,018,050
[45] Apr. 19, 1977

[54] COMPRESSED AIR-OPERATED MOTOR EMPLOYING DUAL LOBE CAMS

[75] Inventor: John R. Murphy, Smithville, Miss.

[73] Assignee: Coy F. Glenn, Sulligent, Ala. ; a part interest

[22] Filed: July 16, 1976

[21] Appl. No.: 705,940

[52] U.S. Cl. 60/370; 60/371; 60/407; 60/412

[51] Int. Cl.² F15B 11/06

[58] Field of Search .... 60/407, 412, 483, 369, 60/370, 371, 374; 91/188, 194, 480, 495; 92/146, 147; 180/44 F

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Washington Evening Star Article of Oct. 20, 1931, & Washington Herald Articles of Oct. 22, 1931 & Nov. 2, 1931, relating to Air Motors for Automobiles, Meyers & Anania "Inventors."

Primary Examiner—Edgar W. Geoghegan
Attorney, Agent, or Firm—Browdy and Neimark

[57] ABSTRACT

An air-operated engine system usable for driving a vehicle by means of compressed air from a rechargeable storage tank. The engine of the system has cylinders containing driving pistons connected to a crankshaft. Compressed air from the storage tank is supplied at regulated pressure to the cylinders for power strokes by means of intake valves and the air is exhausted from the cylinders at the ends of the power strokes by means of exhaust valves. The intake and exhaust valves are operated by dual lobe cams on a camshaft driven from the crankshaft. The air is compressed by a hydrovane compressor which has a constant flow of air operating under 100 pounds pressure with control valves which will take in 25 pounds per minute up to 200 pounds. The output pressure is controlled by the input pressure.

10 Claims, 6 Drawing Figures

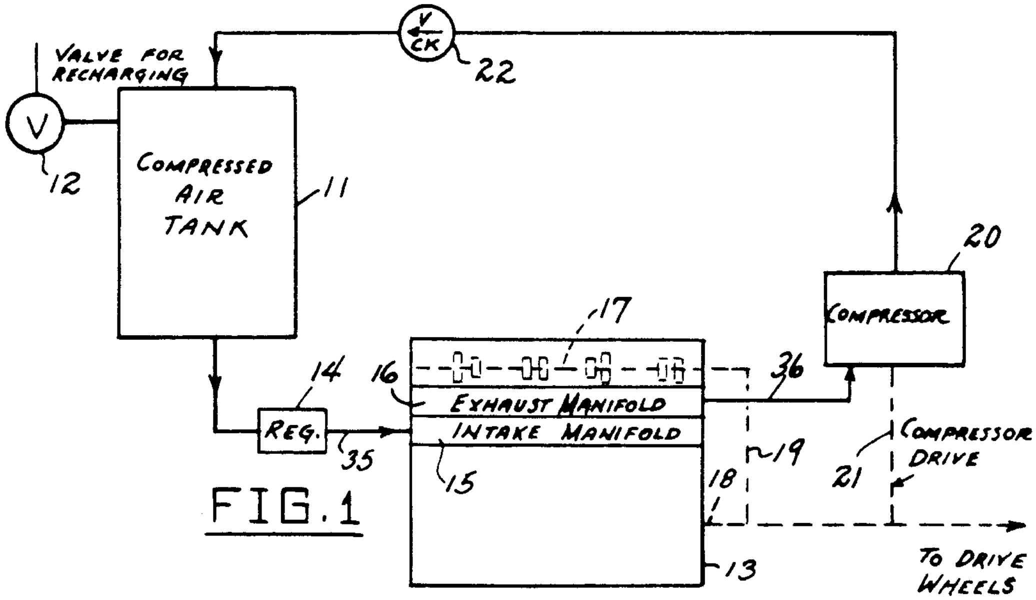

FIG. 1

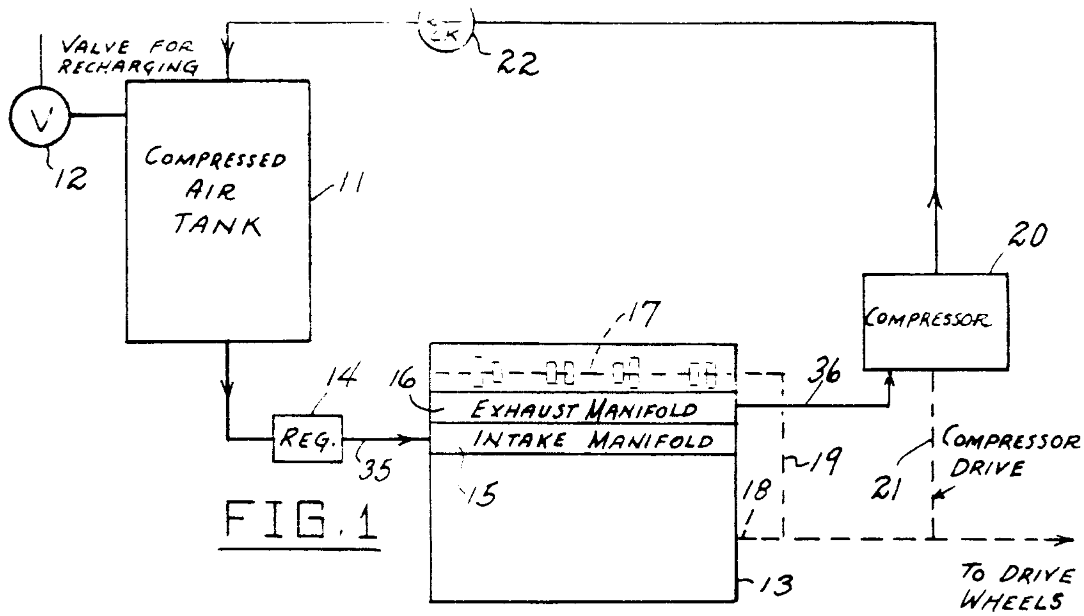

FIG. 1

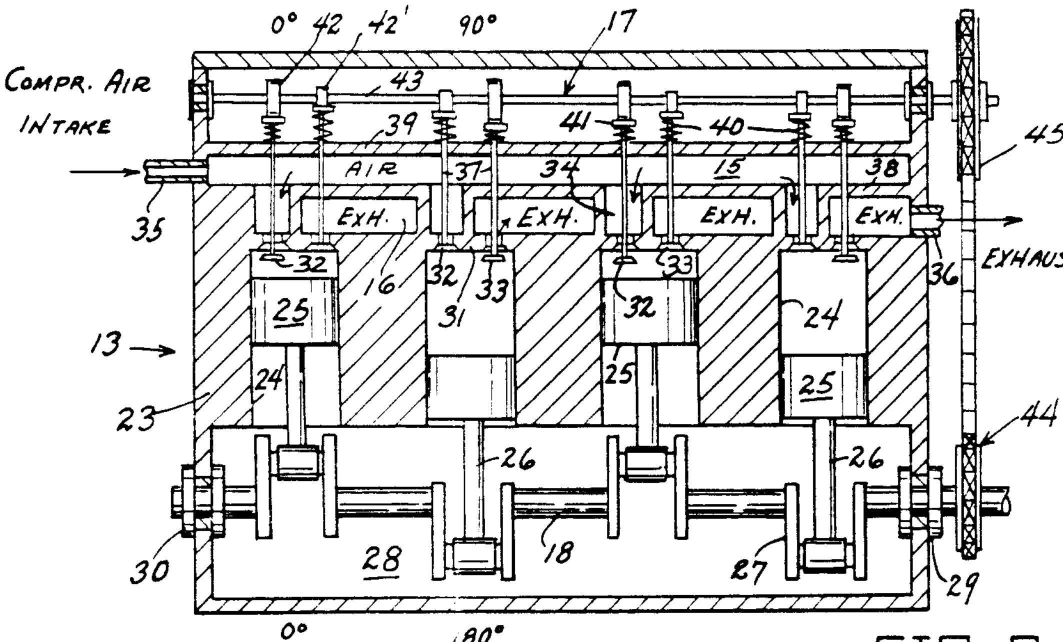

FIG. 2

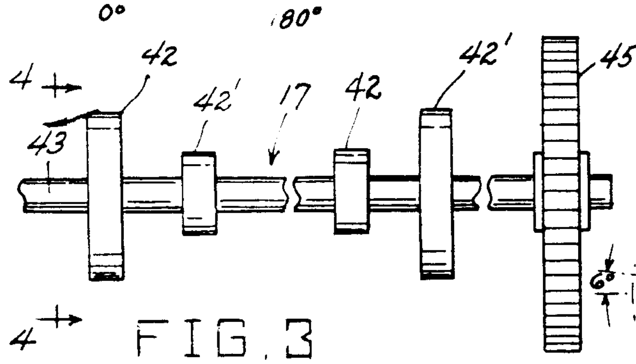

FIG. 3

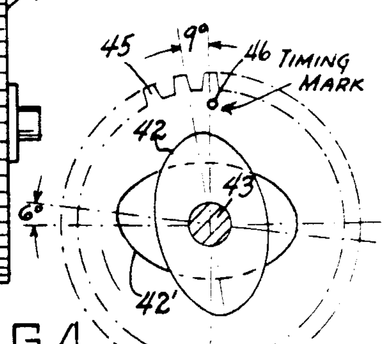

FIG. 4

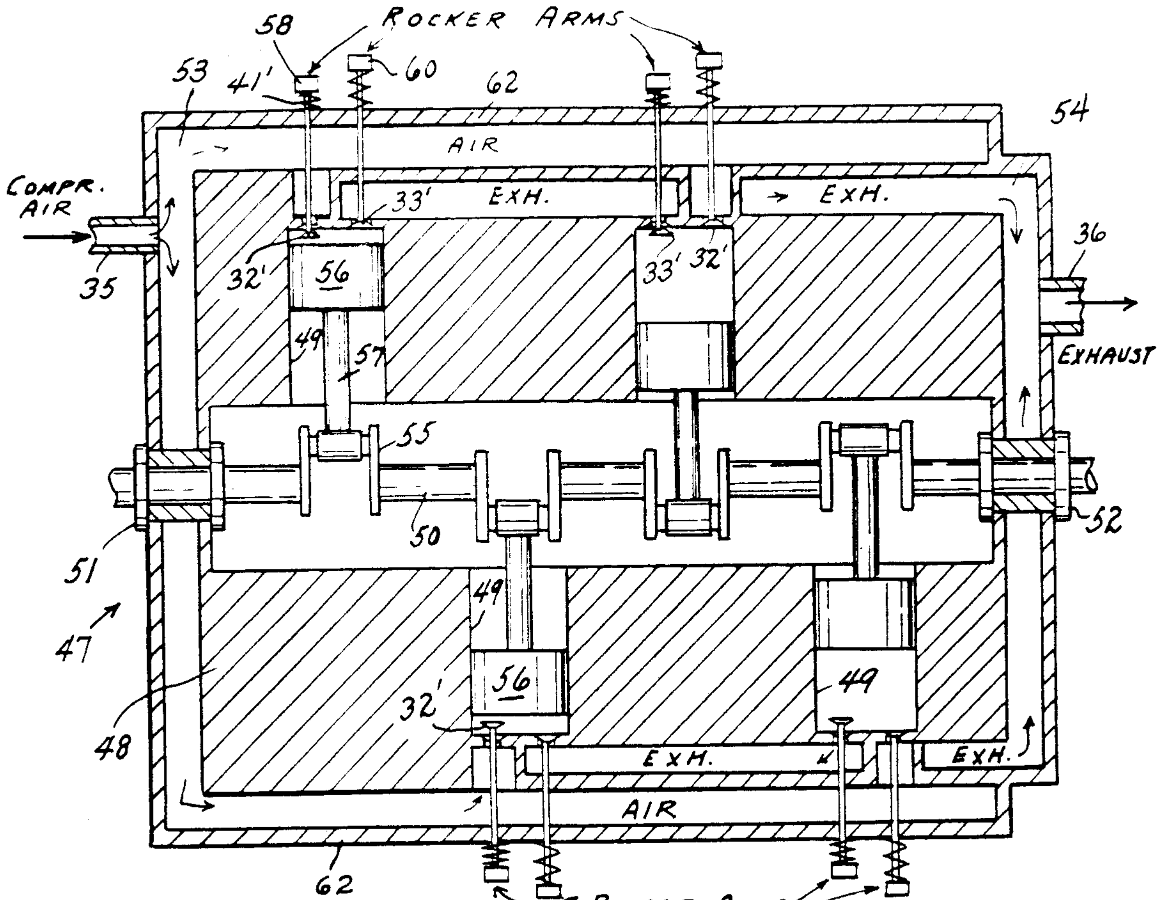
ROCKER ARMS
58
60
53
41'
62
54
AIR
COMPR. AIR
33'
EXH.
EXH.
36
35
32'
56
33'
32'
EXHAUST
49
57
55
50
52
51
47
49
56
49
48
32'
EXH.
EXH.
AIR
62
ROCKER ARMS

FIG. 5

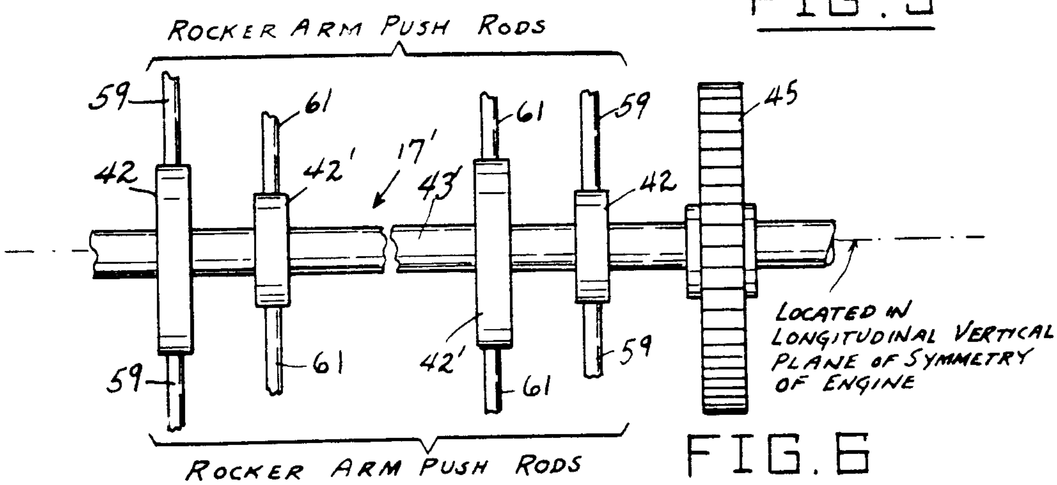
ROCKER ARM PUSH RODS
59
61
61
59
45
42
42'
17'
43
42
59
61
42'
61
59
LOCATED IN LONGITUDINAL VERTICAL PLANE OF SYMMETRY OF ENGINE
ROCKER ARM PUSH RODS

FIG. 6

COMPRESSED AIR-OPERATED MOTOR EMPLOYING DUAL LOBE CAMS

FIELD OF THE INVENTION

This invention relates to compressed air-operated engine systems, and more particularly to an improved compressed air-operated engine system for driving a motor vehicle.

BACKGROUND OF THE INVENTION

In the course of development of pollution-free driving systems for motor vehicles, various systems have been proposed for operating vehicles by means of piston engines driven by compressed air. These systems usually involve the use of a source of compressed air, such as a pressure tank, from which the working fluid is supplied to the engine cyclinders through suitable admission valves suitably timed to provide power strokes of the pistons, and on the return strokes the expanded air is allowed to discharge from the cylinders via suitably timed exhaust valves. The air is filtered by using a hydrovane compressor which has intake filters that remove pollution, making the exhausted air more purified than it was when it entered the compressor. This hydrovane system is a constant flow air compressor. It will put out 25 pounds pressure per minute up to 200 pounds per minute.

SUMMARY OF THE INVENTION

Accordingly, a main object of the invention is to provide a novel and improved compressed air-operated system for a motor vehicle, the system operating totally on compressed air so that it does not pollute the atmosphere, and having highly efficient valve-operating cam means to control the admission of compressed air to the cylinders for the power strokes and to control the release of the air after said power strokes.

A further object of the invention is to provide an improved compressed air-operated engine suitable for driving a motor vehicle, the engine being of the multiple-cylinder type and having properly timed dual-lobed cams for controlling the admission and exhaust of the air to and from the cylinders, and being very economical to operate.

A still further object of the invention is to provide an improved compressed air-operated multiple-cylinder engine suitable for driving a motor vehicle, the engine having a high degree of dynamic balance, being relatively compact in size, and utilizing a simple and efficient dual-lobe cam arrangement to control the admission of compressed air to cylinders wherein the pistons are positioned for power strokes and the exhaust from cylinders wherein the pistons have completed their power strokes.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIG. 1 is a schematic diagram of a typical improved compressed air-operated engine system for a motor vehicle, in accordance with the present invention.

FIG. 2 is a longitudinal vertical cross-sectional view taken through a typical compressed air-operated engine which may be employed in the system of FIG. 1, the engine employing direct-operated admission and exhaust valves controlled by dual-lobed cams according to this invention.

FIG. 3 is an enlarged fragmentary elevational view of the camshaft assembly employed in the typical engine of FIG. 2.

FIG. 4 is a vertical cross-sectional view taken substantially on line 4—4 of FIG. 3.

FIG. 5 is a horizontal cross-sectional view taken through another typical compressed air-operated engine according to the present invention, employing rocker arm-actuated air admission and exhaust valves controlled by dual-lobed cams according to the present invention, said cams controlling rocker arm push rods.

FIG. 6 is a fragmentary elevational view of the camshaft and associated rocker arm push rods employed with the engine of FIG. 5.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, FIG. 1 schematically illustrates the fluid circuit of the engine system in a typical compressed air-driven motor vehicle according to the present invention. The fluid circuit comprises a compressed air storage tank **11** which is chargeable with compressed air from a suitable external source through a control valve **12**. Tank **11** is connected to a compressed air-driven engine **13** through a conventional pressure regulator **14**, whereby to furnish air at a suitable pressure to the intake manifold **15** of the engine. As will be presently described, the compressed air is supplied to the cylinders of the engine through timed air admission valves to provide power strokes of the engine pistons. At the ends of the power strokes the expanded air is exhausted from the cylinders to an exhaust manifold **16** through timed exhaust valves, the opening of the air admission valves and of the exhaust valves being suitably timed by the action of a camshaft assembly **17** driven by the crankshaft **18** through a positive-drive transmission assembly designated generally at **19**. The engine **13** may be of a type wherein the valves are of the poppet type, directly operated by the camshaft assembly, as in FIG. **2**, presently to be described, or of a type employing conventional rocker arms and push rods to couple the camshaft assembly to the valves, as in FIG. **5**, also to be presently described.

The reduced-pressure air from the exhaust manifold **16** is recompressed in a compressor **20** driven by crankshaft **18** by conventional coupling means **21**, and the recompressed air is returned to the storage tank **11** through a conventional check valve **22**.

Crankshaft **18** is drivingly connected in a conventional manner through suitable clutch means and speed-changing means to the driving wheels of the associated vehicle.

Referring to FIGS. **2**, **3** and **4**, the typical engine, shown at **13**, comprises a block **23** formed with four longitudinally aligned cylinders **24** containing pistons **25** connected by connecting rods **26** to the respective crank elements **27** of the crankshaft **18**, contained in a crankcase **28**, the crankshaft being suitably journalled at **29**, **30** in the end walls of the crankcase.

In the typical four-cylinder engine **13**, the crank elements **27** are coplanar but alternate in their crank configurations. Thus, the first and third pistons **25** reach their uppermost positions in their cylinders **24** when the second and fourth pistons reach their lowermost positions, as shown in FIG. 2, and similarly, when the second and fourth pistons reach their uppermost posi-

the push rods **61, 61** engage the opposite maximum-radius portions of said cam **42'** and simultaneously open the exhaust valves **33', 33'** of the first two cylinders, whereas their intake valves **32'** are then closed. This allows the expanded air in the cylinders to be discharged into the exhaust manifold **54**. At this time, the pistons of the third and fourth cylinders are approaching their outermost dead center positions. Shortly after passing said outermost dead center positions their associated push rods **59, 59** open their air admission valves **32'** to generate power strokes of the third and fourth pistons.

As in the first-described embodiment, due to the advance opening of the exhaust valves **33'** for the first and second cylinders, the power strokes developed by the pistons of the third and fourth cylinders will not be opposed by pressure build-up in the first and second cylinders, and similarly, power strokes developed in the first and second cylinders will not be opposed by pressure build-up in the third and fourth cylinders, because of the advance opening of the exhaust valves of said third and fourth cylinders as the pistons in the first and second cylinders approach their outer dead center positions.

The arrangement of FIG. **5** provides improved dynamic balance characteristics due to the substantially symmetrical locations of the first and third cylinders and the second and fourth cylinders with respect to the longitudinal vertical plane containing crankshaft axis. In this respect the configuration of FIG. **5** resembles that of a conventional Volkswagen Model 1300 internal combustion engine.

While certain specific embodiments of an improved compressed air-operated engine system employing dual-lobed cams have been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In an engine system for driving a vehicle, a compressed air storage tank, an engine provided with a plurality of cylinders containing pistons and a crankshaft having crank elements connected to said pistons, compressed air supply conduit means connecting said storage tank to the cylinders and including respective intake valves controlling admission of compressed air to the cylinders for generating power strokes, exhaust conduit means connected to the cylinders and including respective exhaust valves controlling discharge of expanded air from the cylinders, camshaft means drivingly coupled with the crankshaft, said camshaft means including a plurality of dual-lobed cams, and respective follower means engaging said cams and being operatively coupled to said intake and exhaust valves, said cams and follower means being arranged to open the intake valves shortly after the pistons pass their extended dead center positions in the cylinders to generate the power strokes, and to open the exhaust valves shortly before the pistons reach their retracted dead center positions in the cylinders at the ends of said power strokes.

2. The engine system of claim **1**, and means including an air compressor communicatively connecting said exhaust conduit means to said storage tank.

3. The engine system of claim **1**, and wherein said compressed air supply conduit means includes a pressure regulator.

4. The engine system of claim **1**, and wherein the cylinders have end walls, each cylinder having an intake valve and an exhaust valve in its end wall, and wherein the respective dual-lobed cams for operating the intake valve and exhaust valve are spaced longitudinally on said camshaft means with substantially the same spacing as said valves.

5. The engine system of claim **1**, and wherein the dual-lobed cams are each arranged to simultaneously open two valves.

6. The engine system of claim **1**, and wherein the dual-lobed cams are of generally oval shape having opposed maximum-radius portions and the follower means includes two opposing substantially aligned rod elements engaging each cam, said opposing rod elements being operatively connected to the corresponding valves of a pair of cylinders, there being two dual-lobed cams for each pair of cylinders, one set of opposing rod elements being operatively connected to the intake valves of said pair of cylinders and the other set of opposing rod elements being operatively connected to the exhaust valves of said pair of cylinders.

7. The engine system of claim **6**, and wherein the intake valve-operating cam has its major axis approxmately 9° behind the extendedpiston dead center position of said camshaft means, and wherein the exhaust valve-operating cam has its major axis approximately 6° ahead of the retracted-piston dead center position of said camshaft means.

8. The engine system of claim **7**, and wherein the pair of cylinders are substantially coplanar and the cylinders of said pair are located substantially symmetrically on opposite sides of said crankshaft.

9. The engine system of claim **8**, and wherein said crankshaft has crank elements arranged to bring one pair of pistons simultaneously to extended dead center positions while another pair of pistons are brought simultaneously to retracted dead center positions.

10. The engine system of claim **9**, and wherein the cylinders of the engine are substantially coplanar and are arranged substantially in a horizontal plane.

* * * * *

tions, the first and third pistons reach their lowermost positions.

The cylinders have top walls 31 formed with valve ports containing compressed air admission valves 32 and air exhaust valves 33. The air admission ports communicate via conduits 34 with the air intake manifold 15, and the air exhaust ports communicate with the exhaust manifold 16. An air supply conduit 35 connects regulator 14 to intake manifold 15. An exhaust conduit 36 connects exhaust manifold 16 to the inlet of compressor 20.

The valves 32 and 33 have headed valve rods 37 slidably and sealingly engaging through the horizontal manifold walls 38, 39. and are biased upwardly toward closed positions by coiled springs 40 surrounding the valve rods and bearing between the poppet valve heads 41 and the horizontal manifold wall 29. The air admission and exhaust valve heads are respectively engaged by dual-lobed, generally oval cams 42, 42′ rigidly secured on the supporting shaft 43 of camshaft assembly 17.

The camshaft 43 is positively driven by crankshaft 18 by a suitable driving coupling, for example, a chain drive assembly 44 having a camshaft gear 45, providing a 2:1 drive ratio, so that camshaft 43 rotates at one-half the speed of crankshaft 18. Thus, considering the first cylinder 24, its air admission valve 32 opens every 180° of rotation of camshaft 43, namely, at each revolution of crankshaft 18 as the associated piston 25 passes its uppermost position. The associated air admission cam 42 preferably has its maximum radius 9° behind the top dead center mark 46 on the camshaft driving gear 45, as shown in FIG. 4, so that compressed air admission occurs shortly after the piston 25 begins its descent from its top dead center position. Similarly, the air exhaust cam 42′ associated with said first cylinder has its maximum radius 6° ahead of the camshaft position corresponding to bottom dead center of the associated piston 25, whereby the associated exhaust valve 33 opens slightly before the piston reaches its bottom dead center position.

In the arrangement illustrated in FIG. 2, the air admission valves 32 for the first and third cylinders open simultaneously, providing simultaneous power strokes by the first and third pistons; the exhaust valves 33 for the second and fourth cylinders open simultaneously, allowing the expanded air therein to be discharged simultaneouslyinto the exhaust manifold 16. The exhaust valves 33 for the second and fourth cylinders open before the opening of the compressed air admission valves 32 for the first and third cylinders, assuring that their power strokes will not be opposed by compression build-up in the second and fourth cylinders.

The above-described action reverses for every 180° of rotation of crankshaft 18 (every 90° of rotation of camshaft 43).

Delay in the opening of the air admission valves 32 until the pistons have passed top dead center assures that the pistons will have begun their descent at the times that the compressed air is admitted into the associated cylinders and will assure smoothness in the generation of the power strokes.

Referring now to FIGS. 5 and 6, 47 generally designates another typical engine according to the present invention, said engine comprising a block 48 formed with four cylinders 49, said cylinders being substantially horizontally coplanar and being arranged in staggered pairs on opposite sides of a crankshaft 50 suitably journalled at 51, 52 in opposite ends of the block 48. The block is formed with the compressed air intake manifold 53, and inwardly thereof, with the exhaust manifold 54. As shown, the compressed air intake conduit 35 is communicatively connected to intake manifold 53 and the exhaust conduit 36 is communicatively connected to the exhaust manifold 54.

The crankshaft has the respective crank elements 55 connected to pistons 56 in the cylinders 49 by connecting rods 57. The configuration of the crank elements 55 is such that the first and fourth crank elements are in phase, and the second and third crank elements are likewise in phase but are 180° from the first and fourth crank elements. Thus, as shown in FIG. 5, when the piston of the first cylinder is in its outermost position, the piston of the third cylinder, located on the same side of crankshaft 50, is in its innermost position, Similarly, at this time the piston in the second cylinder, at the opposite side of the crankshaft, is in its outermost position and the piston in the fourth cylinder, also at said opposite side, is in its innermost position. Rotation through 180° of crankshaft 50 retracts the first and second pistons to their innermost positions and extends the third and fourth pistons to their outermost positions.

The end walls of the cylinders are provided with valve ports communicating respectively with the intake manifold 53 and the exhuast manifold 54, and with respective air admission valves 32′ and exhaust valves 33′ cooperable with said ports. The air admission valves 32′ have valve rods connected to rocker arms 58 operated by push rods 59 (see FIG. 6), and the exhaust valves 33′ have valve rods connected to rocker arms 60 operated by push rods 61. A camshaft assembly 17′ is journalled in the engine block 48 parallel to crankshaft 50 in a longitudinal vertical plane of symmetry relative to the pairs of cylinders on the opposite sides of the crankshaft, said camshaft assembly having the dual-lobed cams 42, 42′ located between and being engaged by the inner ends of oppositely disposed pairs of push rods 59, 59 and 61, 61, as shown in FIG. 6. Coiled springs 41′ surround the outer end portions of the valve rods and bear between the rocker arms and the outer air manifold walls 62, 62, biasing the valves toward closed positions.

The camshaft, shown at 43′, is driven from the crankshaft 50 in the same manner as described in connection with the embodiment of FIGS. 2 to 4.

The first pair of dual-lobed cams 42, 42′ simultaneously controls the air admission valves 32′ and the exhaust valves 33′ for the first and second cylinders 49, and the second pair of dual-lobed cams 42′, 42 simultaneously controls the exhaust valves 33′ and the air admission valves 32′ of the third and fourth cylinders 49. The push rods 59, 59 for the first and second cylinders 49 simultaneously engage the opposite maximum-radius portions of the first dual-lobed cam 42 to simultaneously open the air admission valves 32′, 32′ for the first and second cylinders,to provide the power strokes of the associated pistons 56, 56. This occurs 9° of camshaft rotation after the outer dead center positions of the pistons, namely, as the pistons begin to move inwardly. The push rods 61, 61 for these clyinders engage the minimum radius portions of the adjacent dual-lobed cam 42′ at this time and allow the exhaust valve 33′ for these cylinders to remain closed. As the pistons approach their innermost dead center positions (6° of camshaft rotation ahead of piston inward dead center)

United States Patent [19]

Stricklin

[11] **4,102,130**

[45] **Jul. 25, 1978**

[54] **CONVERTING AN INTERNAL COMBUSTION ENGINE TO A SINGLE ACTING ENGINE DRIVEN BY STEAM OR COMPRESSED AIR**

[76] Inventor: **Harry Charles Stricklin**, 2004 E. 224th St., Euclid, Ohio 44117

[21] Appl. No.: **668,749**

[22] Filed: **Apr. 19, 1976**

Related U.S. Application Data

[63] Continuation of Ser. No. 455,921, Mar. 28, 1974, abandoned.

[51] **Int. Cl.**[2] **F01L 13/02**; F01B 23/02

[52] **U.S. Cl.** .... **60/407**; 60/370; 60/721; 123/1 R

[58] **Field of Search** .... 60/712, 721, 407, 412, 60/670, 651, 671, 370, 413; 123/21, 1 R; 180/66, 54

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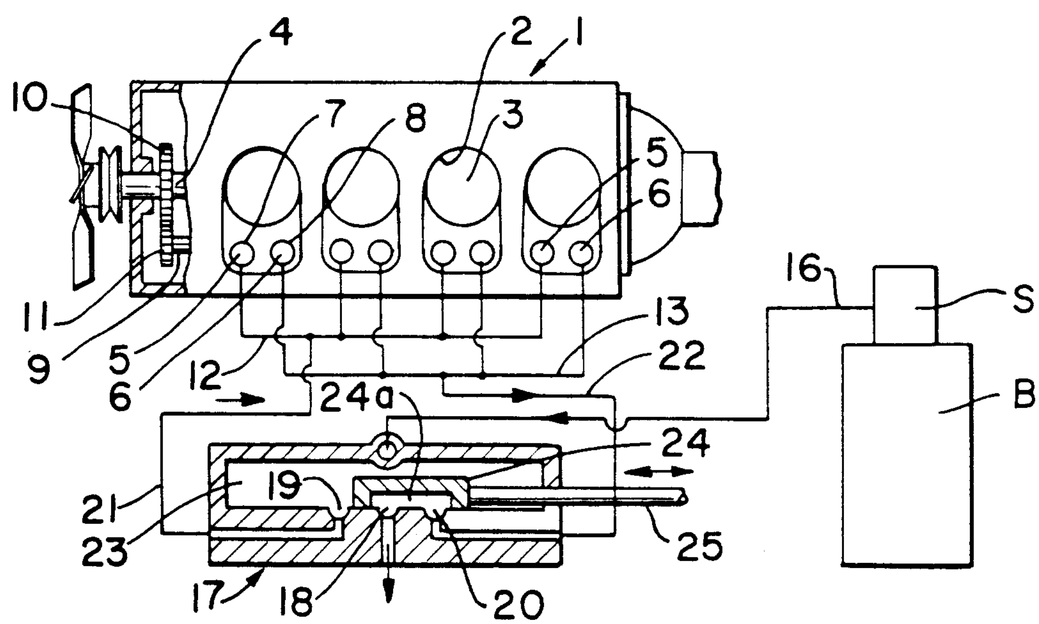
Primary Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—John Harrow Leonard

[57] **ABSTRACT**

The method converts a conventional four cycle internal combustion engine into a single acting reversible steam, or fluid pressure, operated engine by changing the timing cycle of the valves relative to the crankshaft and connecting the valve ports to a reversing valve for admitting live steam to the intake ports while connecting the exhaust ports to the atmosphere, and for reversing the connection, selectively.

3 Claims, 7 Drawing Figures



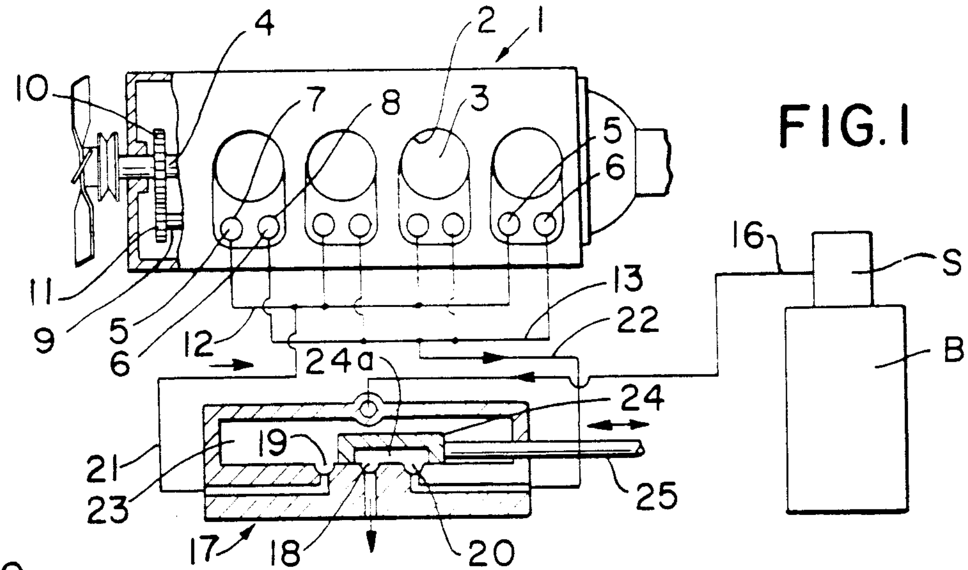


FIG. 1

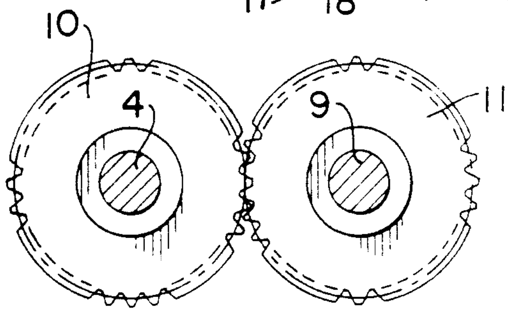


FIG. 2

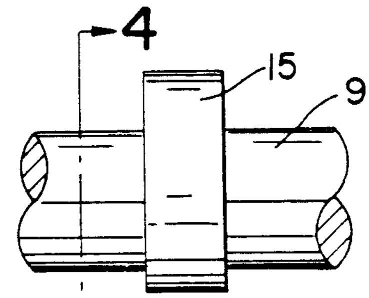


FIG. 3

FIG. 4

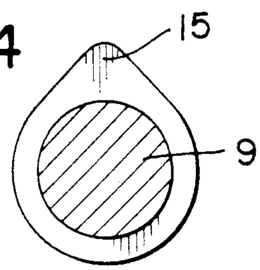


FIG. 5

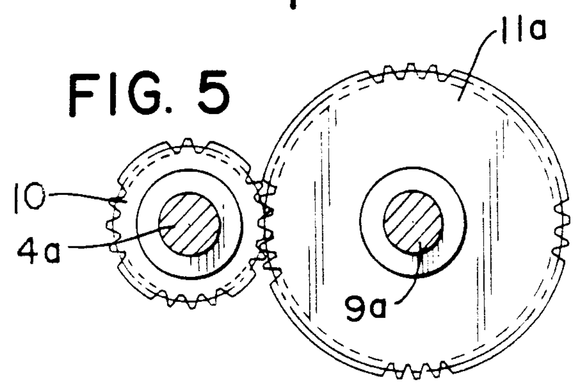


FIG. 6

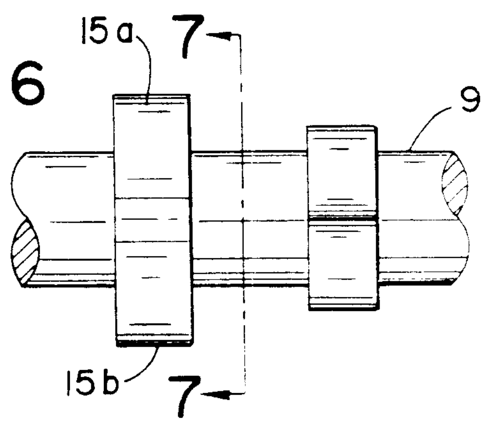
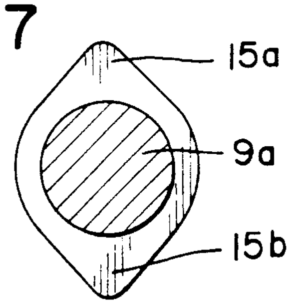


FIG. 7



CONVERTING AN INTERNAL COMBUSTION ENGINE TO A SINGLE ACTING ENGINE DRIVEN BY STEAM OR COMPRESSED AIR

This is a continuation of application Ser. No. 455,921, filed Mar. 28, 1974 now abandoned.

BACKGROUND OF INVENTION

(1) Field of Invention

Conversion of a four cycle internal combustion engine into a single acting reversible, two cycle, steam engine.

(2) Description of Prior Art

Heretofore internal combustion gasoline engines have been provided which can be started rotating by introduction of compressed air, and then shifted to internal combustion operation. Other internal combustion engines have been converted for operation by fluid pressure supplied to the cylinders through the spark plug openings in timed relation to engine speed effected by a common rotary valve driven in timed relation to engine speed effected by a common rotary valve driven in timed relation to the engine speed. In this type of conversion, the original intake valves, or their ports, are permanently closed.

Other compressed air engines have been fabricated, using a multi-cylinder, four cycle internal combustion engine block as the block for a four cycle compressor.

Still other engines operate on the Carnot cycle.

SUMMARY

The present method is for converting a conventional four cycle internal combustion engine into a reversible single acting steam engine by simple changes in the valve timing cycle while retaining intact and utilizing the basic engine structure such as the intake and exhaust valves and ports, pistons, cylinders, crankshaft, and cam shaft. All of the conventional accessories needed for the internal combustion engine operation specifically may be omitted or removed. These include such things as the starter, carburetor, air filter, spark plugs, wiring and distribution system, cooling fan, water pump, transmission and, if desired, the clutch. The spark plug openings are sealed, either by the spark plugs or other plugs. The timing relation of the exhaust valves and intake valves is changed so that each functions as before in relation to the position of its associated piston, but each valve functions once for each revolution of the engine crankshaft instead of once for each two revolutions thereof. This change in timing is effected by either (a) changing the timing gear train to effect a one revolution of the valve operating cam shaft to one revolution of the crankshaft, instead of one revolution of the cam shaft to two revolutions of the crankshaft, or (b) retaining the usual two to one revolutions of the crankshaft to the cam shaft while retaining and using the original cams on the cam shaft, but providing, at the location of each original cam, a duplicate cam spaced 180° about the cam shaft axis from the original cam.

All inlet ports are connected at their inlet sides to a common manifold, and all exhaust ports are connected at their outlet sides to a different manifold common to all of them. The manifolds are connected to a manually settable reversing valve through which live steam is supplied from a boiler. The valve can be set selectively to connect one manifold for receiving live steam and concurrently connecting the other manifold to exhaust, nd for reversing the connection.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic top plan view of a conventional four cycle internal combustion engine, modified in accordance with the present method, and connected to a suitable source of steam through a conventional reversing valve;

FIG. 2 is a diagrammatic end elevation illustrating the modification of the driving gear train for converting the engine of FIG. 1 to a reversible two cycle steam engine;

FIG. 3 is a fragmentary enlarged side elevation of a portion of the cam shaft of the engine illustrated in FIG. 1;

FIG. 4 is a fragmentary cross sectional view of the structure illustrated in FIG. 3;

FIG. 5 is a diagrammatic end elevation of the gear train as originally used in the engine in FIG. 1, when it was used as an internal combustion engine;

FIG. 6 is a fragmentary side elevation of a cam shaft modified for performing the method of the present invention with the original gear train of FIG. 5; and

FIG. 7 is a fragmentary sectional view taken on the line 7—7 of FIG. 6.

Various specific objects and advantages of the invention will become apparent from the following description of a preferred embodiment of the invention.

PREFERRED EMBODIMENT OF THE INVENTION

Referring to the drawings, the invention is disclosed as applied to a conventional four cycle internal combustion engine **1**, having cylinders **2** in which pistons **3** are reciprocable for driving a crankshaft **4**. Each cylinder is provided with an intake poppet valve **5** and exhaust poppet valve **6**. The intake valves **5** control intake ports **7** and the exhaust valves control exhaust ports **8**. The valves are driven in timed relation to the positions of their associated pistons by a common cam shaft **9**, which, in turn, is driven, through a gear train, by the crankshaft **4**. As illustrated, the gear train comprises a driving gear **10** on, and driven by, the crankshaft **4**, and a complementary driven gear **11** on, and driving, the cam shaft **9**, and driven by the gear **10**. The intake ports **7** are connected to a common manifold **12** and the exhaust ports **8** are connected to a common manifold **13**.

The structure above described is that of a conventional four cylinder internal combustion gasoline engine, except for the new relation of the driving gear **10** on the crankshaft **4** and driven gear **11** on the cam shaft **9**, which is best described by reference to FIGS. **2** through **4**.

The internal combustion operation of the engine normally would be in a ratio of one revolution of the cam shaft **9** to two revolutions of the crankshaft **4**. For example, as illustrated in FIG. **5**, to which reference is made hereinafter, originally the driving gear, indicated at **10*a***, would be half the diameter of the driven gear **11*a***. However, in the first embodiment of my invention, as illustrated in FIGS. **2** through **4**, this driving relation is changed and the driving gear **10** and driven gear **11** are the same, so that the cam shaft **9** is driven through one revolution for each revolution of the crankshaft **4**.

The cam shaft **9** retains its original conventional cam **15**, but since the cam shaft **9** is driven one revolution for each revolution of the crankshaft **4**, each valve is opened by its associated cam **15** once each revolution of the crankshaft **4**, instead of once for each two revolu-

tions of the crankshaft **4**. The cams **15**, arranged one for each valve, are retained in their conventional positions and are the same as in the original engine, and thus each cam drives its valve to open and closed positions in the same relation to the position of its associated piston as in the original engine. With this change in the gear train, the engine can be driven in one direction by introducing live steam through either selected one of the manifolds while venting the other manifold to exhaust, and it can be reversed by reversing the connections of the manifolds, respectively, to a source of live steam and exhaust.

As illustrated in FIG. **1**, regardless of the type of conversion, steam is supplied by a suitable boiler B, which may be provided with a super-heater S, from which live steam is supplied through a line **16** to a reversing valve indicated generally at **17**. The reversing valve has an exhaust port **18** and steam supply ports **19** and **20**, respectively. The port **19** is connected by a line **21** to the manifold **12** and the port **20** is connected by a line **22** to the manifold **13**. The reversing valve has a conventional live steam chest **23** in which the supply ports **19** and **20** open so that a supply of live steam can be admitted to them. The admission and exhaust of steam is controlled by a suitable slide **24**, driven manually by an externally extending rod or lever **25**. The slide **24** is arranged so that in one position, such as illustrated in FIG. **1**, it uncovers the port **19**, thus admitting live steam through the line **21** to the manifold **12**. Concurrently, through an internal cavity **24a** in the slide **24**, it connects the port **20** with the exhaust port **18**. Thus live steam is supplied through the line **21** to the manifold **12** and spent steam is exhausted from the manifold **13** by way of the line **22** and exhaust passage **18**. By shifting the slide to the left it can be positioned so that it connects the port **19** to the exhaust port **18** through the cavity **24a** while blocking the exhaust from the port **20** and connecting it to the live steam chest **23**, thus reversing the operation and supplying live steam to the manifold **13** through the line **22** and exhausting the steam from the cylinders through the manifold **12** and line **21**.

Generally, in such reversing valves, the slide **24** is of sufficient length and its controlling lands are of proper size so that the amount of live steam admitted to either manifold can be varied without changing the exhaust capacity, thereby to vary the speed of the engine in the selected direction of rotation.

In converting the engine for steam operation, the spark plug openings are sealed either by the spark plugs themselves or by removing the plugs and installing permanent plugs in the openings therefor.

Thus, by this simple method, the four cycle internal combustion engine is converted to a single acting reversible steam engine, utilizing the original cylinders, pistons, intake and exhaust valves, crankshaft and cam shaft, and eliminating the conventional wiring equipment originally necessitated for carburization and detonation of the fuel in internal combustion engines, and eliminating the usual starter, fan, cooling system and the like.

A modification of the method, as illustrated in FIG. **5**, is to retain the original driving gear train in which the driving gear on the crankshaft is indicated at **10a** and the driven gear on the cam shaft is indicated at **11a**. When these are retained, then the cam shaft, indicated at **9a**, is retained also, but instead of the single cam **15a**, comparable to cam **15**, heretofore described, a duplicate cam **15b** is added to the shaft, one cam **15b** opposite from each cam **15a**, and spaced therefrom 180° about the cam shaft axis. Thus, though the shaft **9a** rotates only once for each two revolutions of the crankshaft, nevertheless, due to the additional or supplemental conversion cam **15b**, each valve is operated twice for each revolution of the cam shaft **9a**, instead of once as heretofore described, and thus each valve is operated once for each revolution of the crankshaft.

The result in the first described method is essentially the same as in the modified method. In each instance, the conversion effected is converting the four cycle internal combustion engine into a single acting reversible steam engine.

The engine, regardless of which method is used, is such that just as each piston passes top dead center, the associated intake valve is opened to admit live steam which drives the piston toward bottom dead center. As the piston approaches bottom dead center, the associated intake valve is closed. As the piston passes bottom dead center, the associated exhaust valve opens and the spent steam is exhausted from the cylinder as the piston returns to top dead center. Just before the piston reaches top dead center, the exhaust valve closes, and as the piston passes top dead center, the intake valve is again opened. This is true for each cylinder if the original engine is more than one cylinder. As a result, each cylinder completes two working strokes in the same number of revolutions of the crankshaft in which only one was produced when the engine operated originally as an internal combustion engine.

Generally, the boiler should be one rated at about 1500° F. working temperature. If desired, a generator driven by the engine and heating elements connected thereto may be provided and cut in when the engine is idling for the purpose of assisting in maintaining steam boiler pressure. The boiler should be of suitable size and shape to provide sufficient water capacity to generate the steam required and to withstand 2000 pounds per square inch of steam pressure. The heating and steam producing elements of the boiler, not shown, may be controlled by conventional thermostats or pressure regulators, necessary operating relays, and the like. The boiler, of course, should be equipped with the usual inlet and outlet fittings, pressure gauges, water level indicators and the like.

If desired, the spent steam from the exhaust of the reversing valve may be passed through a conventional steam oil trap and to a radiator type condenser where the spent steam is condensed to water. This condensation may be passed from the condenser through a suitable water trap which vents any excess steam to the atmosphere while the water is piped back to a conventional water supply for reuse. The water may be passed from the water supply tank to the water jacket of the engine to an injection pump which draws water from the water supply tank and forces it into the boiler through a by-pass valve in the conventional manner which is controlled by the water lever indicating means on the boiler. The injector pump may be driven by any suitable power take-off from the engine. In its broader aspects, the present method is not limited to one particular type of four cycle internal combustion engine. Although the preferred embodiments of the present invention have been described in detail, it is apparent that modification thereof may be made without departing from the spirit of the improvement as defined in the appended claims.

While the engine is shown as operated by steam it could, of course, be operated by any pressurized fluid in which case the boiler B would be replaced by any suitable source of fluid under working pressure. Further, while a four cylinder gasoline four cycle engine is shown for illustration, the method is applicable to both single cylinder and multi-cylinder four cycle engines.

Having thus described my invention, I claim -

1. A method of converting to a single acting, reversible steam engine a four cycle internal combustion engine which includes an engine block, a cylinder therein having an intake port and an exhaust port, an inlet valve and an exhaust valve for said ports, respectively, a piston reciprocable in the cylinder, a crankshaft driven by the piston, a cam shaft, timing gears interconnecting the crankshaft and cam shaft so that the cam shaft is driven by the crankshaft in a ratio of one revolution of the cam shaft to two revolutions of the crankshaft, cams on said cam shaft for the valves, respectively, and arranged one cam for each valve for lifting and lowering the associated valve so as to open and close its associated port in and for a four cycle operation of the engine;

said method comprising:

changing the relation of the camming action on said valves by said cam shaft in relation to the rotation of the crankshaft to cause each of said valves to open and close in substantially the original relation to piston position once per revolution of the crankshaft; then

arranging for continuous introduction of high pressure fluid to the entrance side of said intake port and controlling its passage through said intake port by said inlet valve and for continuous delivery of fluid from the cylinder to the inlet side of the exhaust port and venting of fluid from the outlet side of the exhaust port and controlling the venting through the exhaust port by said exhaust valve, to effect driving of the engine in one direction; and

arranging for manually selectively reversing the introduction and venting of said high pressure fluid to said ports in a manner to effect continuous introduction of the high pressure fluid to the outlet side of the said exhaust port and the continuous venting of the entrance side of the said inlet port, thereby to cause driving of the engine in a direction which is the reverse of said one direction.

2. The method according to claim 1 wherein said changing of the camming action is effected by changing said timing gears to a ratio which causes the cam shaft to be driven by the crankshaft in a one to one relation of revolutions.

3. The method according to claim 1 wherein said changing of the camming action is effected by providing the cam shaft with two substantially duplicate cams, spaced apart from each other 180° about the axis of the cam shaft, for each valve.

* * * * *

Bath man develops engine that runs on nothing but air

THE SUNDAY TELEGRAM, ELMIRA NEW YORK, JULY 31, 1977

By PETE ESPOSITO

BATH — William Long of Bath has invented an engine he says runs on air — the limitless air all around everything and everyone, everywhere.

Just the thoughts of its possible ramifications boggle the mind:

An endless supply of no-cost fuel, free, gratis. Pollution and energy source problems solved in one fell swoop, relatively quickly and inexpensively.

Long, 54, is a self-employed carpenter and plumber who learned his skills through a lifetime of "tinkering with all kinds of machinery" while working at a variety of jobs.

He has had no further formal education since he left high school in 10th grade because he was needed to help on the family farm near Addison. "You learn to do more things on a farm than you can imagine to keep things going," Long said.

Long began "visualizing" the engine in his mind, he said, about 25 years ago and soon after was working on it sporadically over the years.

Four years ago he accelerated work on the engine, "giving it just about all my spare time — nights, weekends, holidays and Sundays," he said.

His son, Timothy, a tool and die apprentice, made several parts for the engine and helped him assemble it and it was completed several months ago after an estimated 5,000 hours of work went into it during the four-year period.

Long's engine looks like and operates

like an air compressor. A regular electric-powered air compressor is used to start his engine, but after it is started the air compressor is disconnected and his engine continues to run on the air it takes from the air around it, Long says. He has run it continuously for varying periods, the longest five days and five nights, he said.

The engine has a tank about three feet long and 18 inches in diameter, a flywheel, a single cylinder and several other parts. It is about four feet wide and four feet high overall and weighs about 175 pounds. He has no name for it other than "the engine." He calls it a "working model" and others can be made larger or smaller.

"All I've done is learn to control air, how to store it and use it," Long stresses. He feels the situation is similar to being at the threshhold of the beginning of the practical use of gas and oil.

He is reluctant to disclose all details about his engine because he has not patented it and is currently in touch with three nationally-known companies who have shown some interest in it.

One auto company already has just about said "not interested." Officials of area companies also are aware of Long's engine and have discussed it with him.

One mechanical engineer told him, "basically, what I have is against the law of physics — it's not in the engineering manual and so it doesn't exist," the easy-going Long said, laughing at the recollection.

"I'm not using perpetual motion — there is no such thing; I know all about that," he added.

"I've been called everything from a crackpot to a basket case and been laughed at by the best of engineers and other people. Do I mind? Hell, no. I know I know what I have; you can't discourage me a bit. The crackpots might be those that can't see past their noses."

Long says he wants "to see this (his engine) do people some good." His engine can be used, he said, as a stationary power source, to operate, for example, a lathe or other factory machinery, or adapted to power a car or truck. He is currently toying with the idea of installing his engine in a small pickup truck.

Long also said a top federal official involved with energy is aware of his invention. He hasn't heard anything further from this source to date, he said.

Bringing feelers from some possible users of his engine were a recent report of it in an area newspaper and his appearance with the engine on an area television program.

"All I want from this engine is enough for me and my family to be able to get along the rest of our days," Long said.

His wife, the former Miss Pauline Jackson of Corning, seems to be as knowledgeable about the engine as its inventor. There is no doubt she has been a staunch supporter throughout, with her husband 100 per cent. The couple also has a married daughter, a librarian, working in a school in the south.

After his marriage during World War II, he left the family dairy farm and bought and operated his own in the Town of Addison. He sold it because he expected to be called into the army, but he wasn't summoned.

If he isn't able to sell his engine soon, Long said, "I'll put it in my pick up truck and drive it to Washington, D.C. and maybe that'll wake up some people."

William Long and "the engine."

United States Patent [19] [11] 4,163,367
Yeh [45] Aug. 7, 1979

[54] HYBRID FLYWHEEL/COMPRESSED-FLUID PROPULSION SYSTEM FOR NONSTATIONARY APPLICATIONS

[76] Inventor: George C. Yeh, 2 Smedley Dr., Newtown Square, Pa. 19073

[21] Appl. No.: 867,694

[22] Filed: Jan. 9, 1978

[51] Int. Cl.[2] F15B 1/02

[52] U.S. Cl. 60/414; 60/416; 60/643; 60/668; 180/165; 180/302

[58] Field of Search .... 60/371, 407, 408, 413, 60/414, 416, 643, 659, 668, 698, 701; 180/44 F, 44 M, 65 A, 66 B; 74/572

[56] References Cited

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3,379,008	4/1968	Manganaro	60/408 X
3,553,901	1/1971	Jacobus	60/404 X
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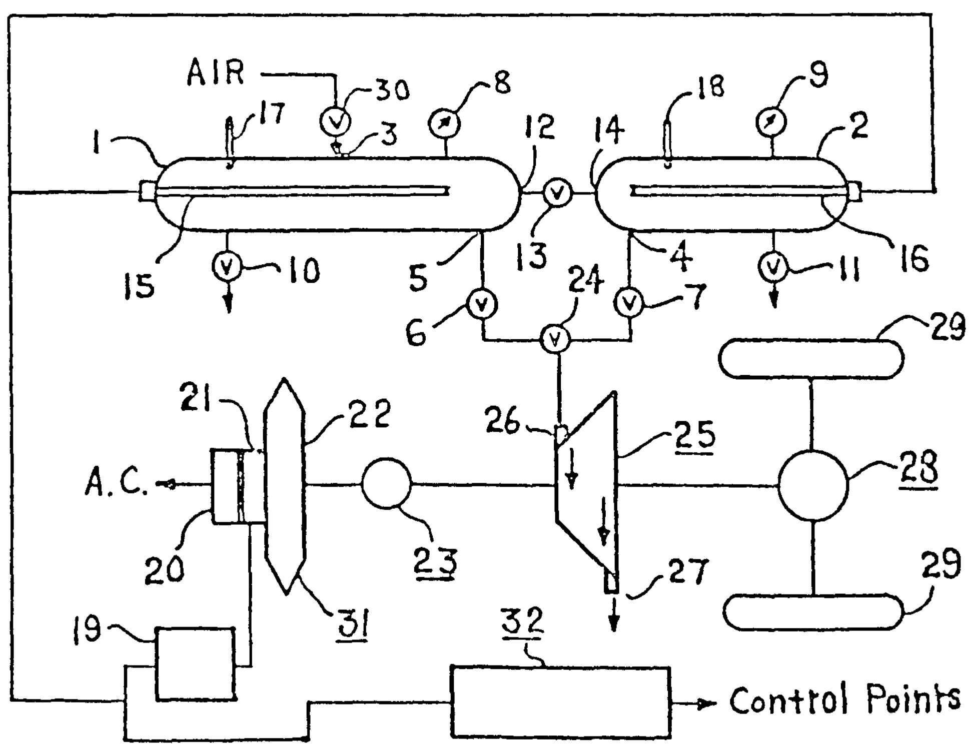
2359721	6/1975	Fed. Rep. of Germany	180/66 B

Primary Examiner—Edgar W. Geoghegan
Attorney, Agent, or Firm—James Albert Drobile

[57] ABSTRACT

The adaptation of a compressed-fluid (such as compressed-air) powered turbine in conjunction with the use of a flywheel as a hybrid propulsion system for nonstationary applications, such as vehicle drive, is shown and its practicality demonstrated. This propulsion system requires a nonpolluting fluid, such as air, and a source of mechanical or electrical energy to compress said fluid and energize said flywheel, both of which act as energy storage media. An expander/compressor unit, such as a turbine, is used for converting the stored energy of said compressed-fluid into shaft power by expanding said fluid, and recovering the braking energy during vehicle deceleration by compressing and storing the atmospheric air (if air is used). Said flywheel is used not only for providing peak powers necessary for vehicle acceleration but also for recovering the braking energy during vehicle deceleration and refilling said compressed-fluid in an emergency. The propulsion system can use the unlimited supply of air as the primary energy-storage medium and said flywheel as the secondary energy-storage medium. The propulsion system is not only regenerative but also quick-recharging; it, therefore, has high energy-efficiencies and broad applications.

6 Claims, 2 Drawing Figures



United States Patent [19] [11] 4,178,759
Cook [45] Dec. 18, 1979

[54] ION REPULSION ENGINE AND METHOD OF OPERATING SAME

[76] Inventor: Billy G. Cook, 140 E. Millan St., Chula Vista, Calif. 92010

[21] Appl. No.: 894,474

[22] Filed: Apr. 7, 1978

[51] Int. Cl.² F03G 7/00
[52] U.S. Cl. 60/721; 310/10
[58] Field of Search 60/721; 310/10

[56] References Cited

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3,585,420	6/1971	Gourdine	310/10
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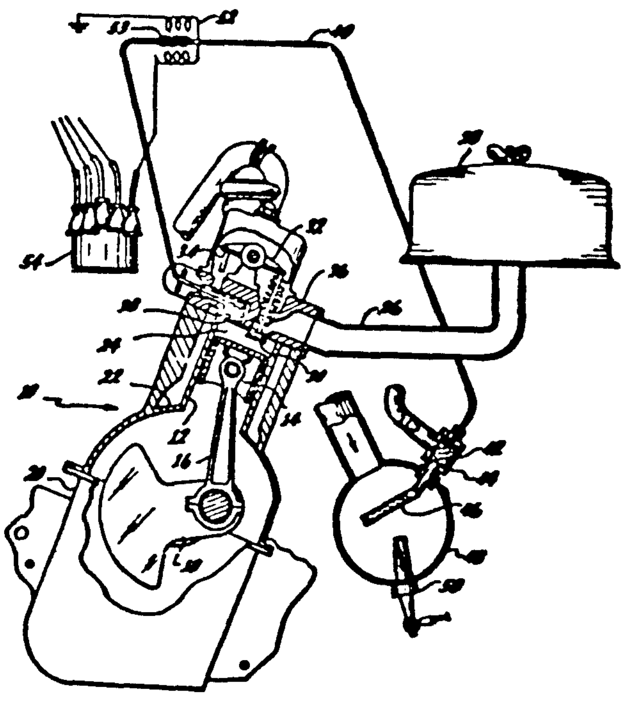
Primary Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—Frank D. Gilliam

[57] ABSTRACT

A reciprocating engine utilizing the mutual repulsion of charged air particles to drive a work-producing means. The engine has pistons reciprocating in cylinders with cylinder spaces between cylinder heads and the pistons. A first enclosed porous conductive electrode is located in fluid flow communication with the cylinder space, typically within the cylinder space itself. The first porous electrode is electrically connected to a second conductive porous electrode in a separate housing. Air is admitted into the first electrode while fuel is admitted into the second electrode. As the air in the cylinder space and first electrode is compressed as the piston moves toward the cylinder head, a current flow takes place from the first electrode to the second electrode because of valance attraction between fuel molecules and oxygen electrons resulting in the ionization of oxygen and fuel. Preferably, the two electrodes are maintained at an elevated temperature to enhance the air/fuel reaction to provide improved ionization. An electrochemical reaction occurs similar to that which occurs in fuel cells. The mutual repulsion of the charged ions in the cylinder space and first electrode produces a strong force on the piston, in accordance with Coulomb's Law, resulting in a piston power stroke. The ionized gases from the cylinder and the external housing are exhausted to a combustion chamber for the completion of the air/fuel chemical reaction. During the initial stages of the compression stroke, premature ionization may be prevented by inducing a potential in the inter-electrode conductor opposite to that produced during ionization.

11 Claims, 12 Drawing Figures



United States Patent [19] **Rilett**

[11] **4,092,830**
[45] **June 6, 1978**

[54] **GAS DRIVEN MOTOR WITH BUFFER SPACE**

[76] Inventor: **John Walter Rilett,** 18 Links View, Stratton, Cirencester, England

[21] Appl. No.: **759,133**

[22] Filed: **Jan. 13, 1977**

[30] **Foreign Application Priority Data**

Jan. 16, 1976	United Kingdom	1689/76
Jun. 21, 1976	United Kingdom	25600/76

[51] **Int. Cl.**^{2} **F01K 25/10**
[52] **U.S. Cl.** **60/671**; 62/50
[58] **Field of Search** 60/651, 671; 62/50

[56] **References Cited**

U.S. PATENT DOCUMENTS

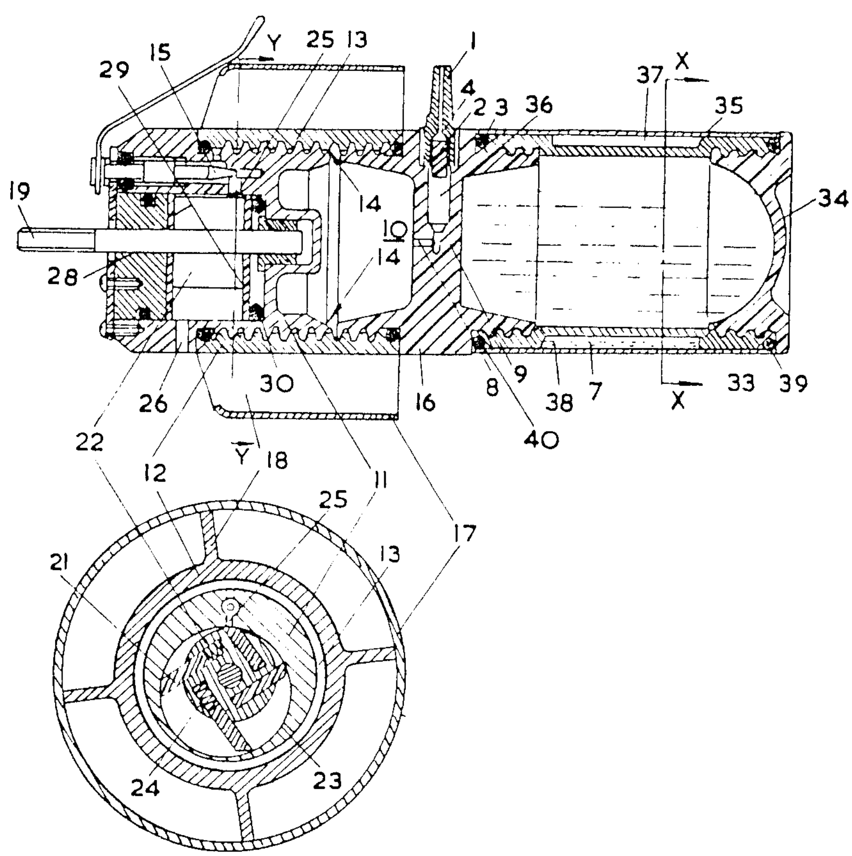
3,062,017	11/1962	Balcar	62/50
3,941,124	3/1976	Rodewald	62/50 X
3,987,632	10/1976	Pereda	60/671

Primary Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—Dennison, Dennison, Meserole & Pollack

[57] **ABSTRACT**

A motor of the kind which is driven by gas evaporated from a liquefied gas has in combination therewith gas supply apparatus comprising a vessel containing the liquefied gas, a passage in communication with the motor for the flow of gas evaporating from the liquefied gas in the vessel, valve or other means operable to permit gas evaporating from the liquefied gas to flow into the motor, and, in thermal communication with the vessel or the passage (or both), a container charged with a buffer substance (which is normally a liquid which has a freezing point at normal pressure above the boiling point of the liquefied gas) which acts as a source of heat.

10 Claims, 7 Drawing Figures



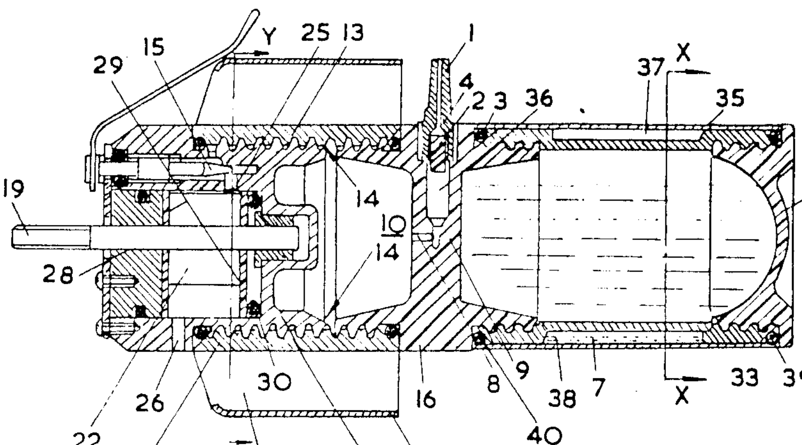


FIG.1

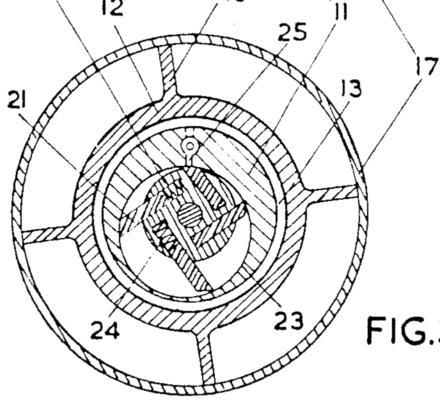


FIG.3

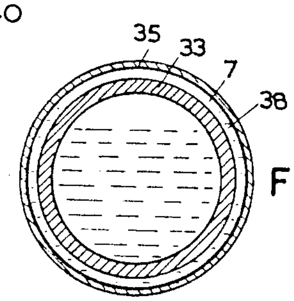


FIG. 2

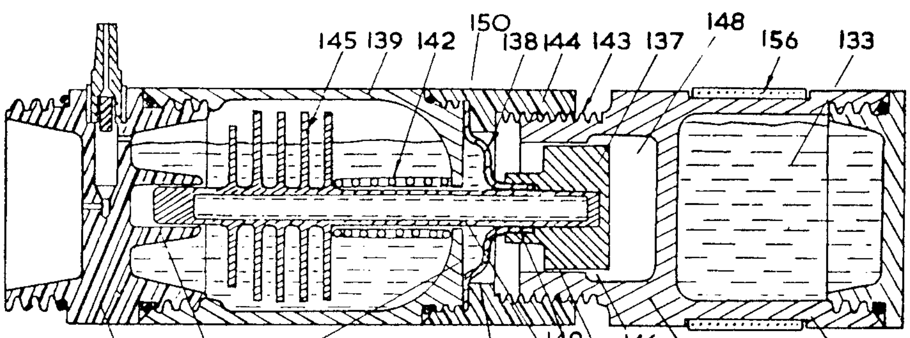


FIG.4

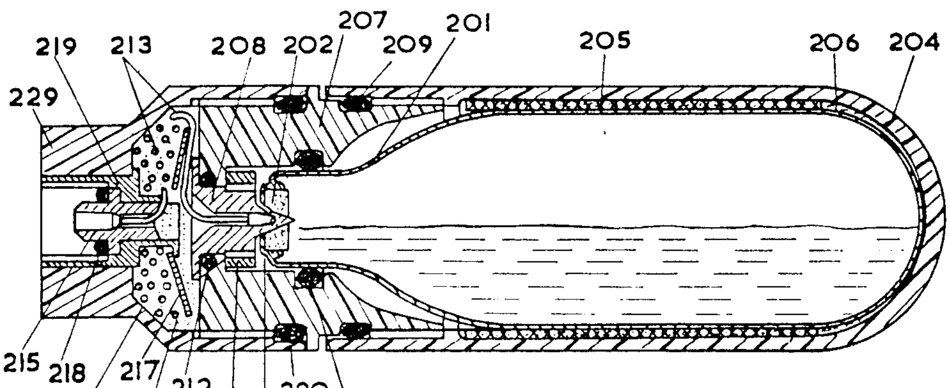


FIG.5

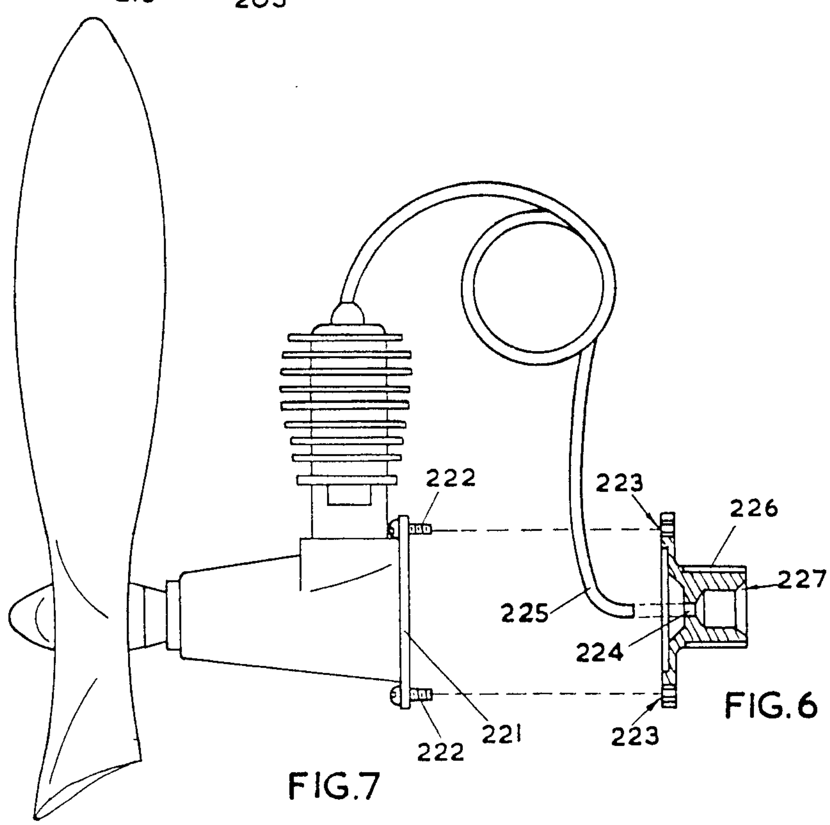


FIG.6

FIG.7

GAS DRIVEN MOTOR WITH BUFFER SPACE

BACKGROUND OF THE INVENTION

(a) Field of the Disclosure

This invention relates to motors of the kind that are driven by gas evaporated from a liquefied gas such as liquid carbon dioxide or liquid nitrogen.

(b) Description of the Prior Art

Motors which run on liquefied gases are known and have for instance been used to drive model aircraft (using sometimes a bottle of pressure-liquefied carbon dioxide).

A major difficulty which arises with such motors is the progressive fall in gas pressure which occurs as gas flows from the bottle or tank in order to drive the motor, and which limits the power of the motor to a rather low level. This fall in pressure is a consequence of the cooling of the gas as it attempts to evaporate from the liquid state in the supply bottle and to expand against ambient pressure during consumption by the motor. This cooling effect becomes worse as one attempts to increase the speed and power of the motor and can even cause formation of ice on the outside of the bottle. Furthermore the cooling of the gas causes its density to increase with the result that gas consumption is increased undesirably. A further disadvantage of existing motors powered by vaporised gas arises because the gas taken from the bottle for such existing motors is at or near the condition known as "saturation" with the consequence that, as soon as it is expanded in the motor, it inevitably condenses partly back into its liquid or even its solid state.

Apart from the possibility of damage to the motor such condensation also causes a large increase in the specific volume of the working fluid and this requires that the motor should have a high expansion ratio in order adequately to expand the working fluid and so extract its available energy, and this in turn leads to the need for an undesirably large motor, or to an undesirably low charge volume (which reduces motor power), or to the need for excessively high rpm in order to secure sufficient power from the motor. Our proposal for overcoming the problem of condensation of the gas in the motor is to superheat the gas before use in the motor, that is, to increase its temperature at sensibly constant pressure, or to reduce its pressure at sensibly constant temperature (or any combination of these two processes).

Although the value of superheating has sometimes been recognised in existing motors, the usual technique of achieving it has been by leading the gas from the supply bottle through fine-bore metal tubing before admission to the motor, this metal tubing usually being coiled and positioned so that ambient air flows over the tubing during operation. Existing motors are usually adapted to fly model planes and so have a propellor which blows air over the metal tubing. This technique gives a small but significant improvement in performance, though not overcoming the problem of condensation, diseconomy, power loss and possible motor damage at high power settings and, being reliant on the temperature of the ambient air to provide the superheating, is not very effective in cold weather when the extent of power loss can be severe. Moreover it does not give a significant expansion of the gas as it passes to the motor.

It is well known to heat by means of circulating warm fluids, parts of liquefied gas storage apparatus so as to prevent excessive frost from being deposited on such as apparatus during storage of the liquefied gas. Such heating systems are, for example, disclosed in U.S. Pat. Nos. 3,122,891 and 3,850,001.

It has been proposed in U.S. Pat. No. 3,466,196 to surround with a water jacket electronic equipment sealed in a shell before the shell is launched from the earth as part of an orbiting satellite or weather balloon. If the satellite or weather balloon reaches an altitude in the order of 30,000 meters it will be subjected to a temperature of $-50°$ to $60°$ C. At such temperatures the water freezes thereby providing longterm protection of the equipment against extreme cold.

OBJECTS OF THE INVENTION

It is an object of the invention to provide improved means for superheating the gas evaporated from the liquefied gas.

It is a further object of the invention to provide gas supply apparatus for driving a small motor suitable for powering a model or toy aircraft.

GENERAL DESCRIPTION OF INVENTION

According to the invention there is provided a motor having in combination therewith apparatus for supplying to the motor gas evaporated from liquefied gas, said apparatus comprising a vessel containing liquefied gas, a passage which affords communication between the vessel and the motor whereby gas evaporating from the liquefied gas is conducted into the motor, and, in heat conductive relationship with the vessel, at least one container holding a buffer substance which during operation of the motor releases heat to the vessel and the liquefied gas therein whereby the tendency of the evaporation of the liquefied gas to cool the remaining liquefied gas in the vessel is at least partly counteracted.

The invention also provides a motor having in combination therewith apparatus for supplying to the motor gas evaporated from liquefied gas, said apparatus comprising a vessel containing liquefied gas, a passage which affords communication between the vessel and the motor whereby gas evaporating from the liquefied gas is conducted into the motor, and, in heat conductive relationship with at least one container holding a buffer substance which during operation of the motor releases heat to evaporated gas as it passes through the passage thereby raising the temperature of said evaporated gas.

By the term "buffer substance" is meant a substance which undergoes a change in its physical, chemical, crystallographic or other state at a temperature between ambient temperature and the final operating temperature of the liquefied gas, the change of state then causing a release of heat, or which by other means releases heat (eg sensible heat) to the liquid or evaporated gas.

This heat may be derived from its latent heat of fusion, or from its latent heat of vapourisation, or from its heat of hydration, or from any other effect which causes a significant release of heat at a certain falling temperature and which, advantageously, re-absorbs that heat reversibly as the temperature rises again. Substances from which the buffer substance may be selected include a very large number of alternatives (as listed for instance in the CRC "Handbook of Chemistry and Physics", 55th Edition, Pages, B63 to B156, B-243 to B-247, C-639 to C-658, and C-680 to C-179).

Motors making use of this buffering technique are referred to herein as "stored energy motors" because their buffer substances effectively store heat energy which is released. to the working fluid for conversion into power as the motor runs. In the case of stored energy motors running on CO_2 at normal ambient temperatures, suitable buffers include acetic acid (MP circa 16° C), formic acid (MP circa 8° C), and water (MP 0° C), and mixtures of these materials which allow other melting points to be achieved: for instance a mixture of 99% acetic acid and 1% water by volume has a melting point near 10° C which is useful for stored energy motors running in temperate climates. The above buffers are attractive by virtue of their high latent heats of fusion, whereby a relatively small amount of buffer substance suffices (eg one gram of buffer per three or four grams of CO_2 in the case of a water buffer). The above buffers are also very inexpensive and so may be used, for example, in disposable CO_2 bulbs. Another desirable quality of the buffer substance is a high thermal conductivity, to facilitate heat flow from the buffer into the CO_2 (or other gas being used), and into the buffer from the surrounding environment. Water is particularly good in this respect. The function of the buffer substance in thermal contact with the vessel is to prevent the liquefied gas from sustaining a serious fall in temperature and pressure as it evaporates. The buffer achieves this function by releasing heat to the liquefied gas as its temperature attempts to fall. For example the buffer may be a substance which has a melting point of 0° to 10° C and which is therefore in its liquid state at normal ambient temperatures. Then, in the case of a CO_2 motor for example (though the invention is equally applicable to other gases), as the CO_2 gas is drawn off to drive the motor the remaining CO_2 in the bottle will become colder but, being in good thermal communication with the buffer, the buffer will also become colder. However the buffer will resist this fall in temperature in two ways: firstly by releasing its own sensible heat as its temperature falls towards the freezing temperature of the buffer and below; and secondly when its temperature falls slightly below the freezing point it will begin to freeze and, in doing so, it will release its latent heat of fusion to the CO_2 in the supply bottle and so arrest the fall in temperature of the CO_2 at a level not far below the freezing point of the buffer thus maintaining the pressure of the CO_2 and the power of the motor at a sensibly constant level.

At the end of the power run the buffer will furthermore melt again as heat from the surrounding environment flows naturally into it. This provides a further store of heat energy for the next run of the motor and this process may of course be repeated indefinitely.

The vessel may if desired be detachable from the rest of the motor. It may be disposable or refillable. If desired, gas supply apparatus may be provided to convert an existing motor into one according to the present invention. Another possibility is to provide gas supply apparatus which may be used interchangeably with more than one motor. Such gas supply apparatus may have a passage in thermal communication with a container for buffer substance. By appropriately selecting the buffer substance a suitable degree of superheating may thereby be achieved.

According to another aspect of the present invention there is provided gas supply apparatus for use in association with a motor to constitute the motor according to the first aspect of the invention, the gas supply apparatus comprising a vessel containing liquefied gas under pressure or capable of being charged with liquefied gas, a passage in communication at one of its ends with the vessel or being capable of being placed in communication with the vessel by operation of valve or other means, which apparatus has in heat conductive relationship with the vessel or the passage or both at least one container holding or capable of being charged with buffer substance (as hereinbefore defined), and adaptor means capable of connecting the gas supply apparatus to the motor such that the outlet of the passage communicates with the chamber(s) which house(s) the rotary or reciprocable element(s) of the motor.

If desired, the passage may form part of a superheater. Alternatively, the superheater may be provided in the body of the motor itself.

Advantageously the adaptor is shaped to match the mounting flange of the motor so that the motor may be fixed to the adaptor. The adaptor is next provided with one socket (or a plurality of sockets, in the case of existing motors with more than one cylinder) so that the inlet feed tubing of the existing motor may be easily soldered into this socket. Alternatively one may provide an 'O' ring or olive connection between the inlet feed pipe and the adaptor, in the known manner of pipe couplings. The adaptor is also advantageously provided with means (preferably sealed by an 'O' ring) to provide a gas-tight connection with the gas supply apparatus, preferably in the form of a screw coupling or snap coupling. By this means, once the adaptor has been connected and fixed to the motor, the motor may be quickly fitted to the gas supply apparatus, and repeatedly removed and recoupled if so desired. This facility is particularly desirable in its application to model aircraft and toys, since it allows one motor to be quickly moved from one model or toy to another as desired, each model or toy having its own individual gas supply apparatus permanently fitted. The adaptor may be a male or female member on the gas supply apparatus adapted to mate with a complimentary female or male member on the motor.

If desired the vessel may be a sealed bulb containing liquefied gas. The motor or gas supply apparatus may have piercing means capable of breaking the seal and thereby placing the vessel in communication with the passage. Accordingly, a yet further aspect of the present invention provides gas supply apparatus for association with a positive-displacement or turbine motor to constitute a motor according to the first aspect of the invention, the gas supply apparatus including a holder adapted to receive a vessel containing liquefied gas, the holder having on its inner surface:

(a) a closed or refillable jacket containing or adapted to be charged with buffer substance (as hereinbefore defined) such that on insertion of the vessel into the holder, the jacket comes into heat-conducting relationship with the vessel; or

(b) sealing means adapted to make a liquid-tight seal with the vessel, the holder being shaped and constructed such that it is capable of defining with the vessel a jacket for buffer substance (as hereinbefore defined) around the vessel, and a body member or body assembly engageable with the holder and the motor or an adaptor connected to the motor, the body member or body assembly having a passage able to be placed in communication at one of its ends with the ullage space of the vessel and at its other end with a chamber (or

chambers) housing the rotary or reciprocable element(s) of the motor.

The motor or gas supply apparatus according to the invention may be sold with the or each container charged with buffer substance. Alternatively, the or each container may be adapted to be charged with buffer substance by the user of the motor.

The container may conveniently comprise a jacket surrounding the vessel. It is advantageous to encourage the flow of heat by the use of metal foam to carry the buffer (especially when the buffer is in a cavity or jacket surrounding the vessel), or partly to fill the container or jacket holding the buffer with fine metal mesh, gauze, filings, swarf, powder or woven or knitted metal wire so as to form a latticework of heat flow paths throughout the buffer. It is advantageous to arrange for the length of these heat flow paths within the latticework to be as small as possible as a means of increasing the rate of heat transfer, together with the use of the smallest convenient size of pocket or voids containing the buffer. The or each container may alternatively be situated in the vessel itself. A closed tube or small capsules may for example be used. The size of such capsules should preferably be below 1 mm diameter and preferably as small as 0.2 mm diameter.

In the case of disposable or other supply bulbs (for example "Sparklets" (RTM) bulbs of CO_2) which are to be enclosed within a jacket containing the buffer, it is desirable either to make such bulbs from a high thermal conductivity material which is also corrosion resistant (such as aluminium or one of its alloys) or, if it is made of an inexpensive but corrodible material such as steel (as in the case of standard "Sparklets" bulbs), to plate or paint or coat the surface of the supply bottle with a corrosion-resisting material which is also a good conductor of heat. Conventional paints are not satisfactory in this respect being poor conductors of heat and it is advantageous to use a paint which is, firstly, applied as a coating of less than 0.1 mm (and preferably less than 0.05 mm) in thickness and, secondly, which has a thermal conductivity of at least 0.002 cal/sec.cm.° C and preferably nearer to 0.005 cal/sec.cm.° C, after application and subsequent drying or curing. This may be achieved with paints containing finely divided metals such as aluminium powder, or finely divided metal oxides such as zinc oxide or benyllium oxide or finely divided graphite such as "Shawinigan" Black in which the graphite is in the form of tiny needless which tend to link up to form heat flow paths, or other fillers which allow the thermal conductivity to reach the figures specified above.

Alternatively the tank may be made of inexpensive material such as plastics, and, because such material may not conduct heat very effectively, the buffer may be held within the vessel in a closed tube or in small capsules.

A preferred way of achieving an effective degree of superheating in accordance with the invention is to arrange for the passage to be so adapted that it causes, in operation of the motor, a pressure drop of more than 10% of the saturation pressure of the liquid gas at the prevailing temperature, whereby the speed of the motor is able to be stabilised. Thus, the passage may for at least part of it's length define a tortuous or winding path for the flow of evaporated gas from the vessel to the motor. At least part of the tortuous or winding path is preferably in heat-conductive relationship with a container holding or capable of being charged with buffer substance. Preferably, the buffer substance in thermal contact with the superheater has a freezing point greater than that of the buffer substance in thermal contact with the vessel. The passage may at least in part be defined by coiling tubing. The tubing may have a length of from ½ to 1 meter and a bore of up to, say, 0.25 mm. By way of example, gas boiled off at a little below 0° C from a vessel buffered with water may then be superheated to approximately 10° C by means of an acetic acid buffer (MP about 12° C by means of water addition). In addition the long fine-bore superheater coil causes a pressure reduction of typically 150 psi (compared with typically 0.2 p.s.i. in previously known designs), which helps to bring about the required degree of superheating heat transfer and which, furthermore, causes any incipient slowing down of the motor to be compensated for by a lessening of such pressure reduction (i.e. it causes an increase in gas supply pressure to the motor) which tends to stabilise the motor speed and power. Alternatively the pressure drop may be effected by providing a porous plate or plug in the passsage.

Existing CO_2 motors, when linked with gas supply apparatus employing buffering of the vessel and superheater can develop three to five times as much power, higher and more constant r.p.m., freedom from icing, condensation and risk of motor damage, and adequate performance in cold weather.

The motors according to the invention may be employed in such things as power tools (domestic and industrial), hedge-trimmers, portable chain saws, toys, models, dentists' drills, lawn mowers and light automotive vehicles. They are particularly suitable for use in toy or model aeroplanes. Particular advantages of the motor according to the invention include its avoidance of the need for a trailing electrical power lead (as in domestic power tools etc) or compressed-air hose (as in industrial power drills and garage equipments); the rapidity with which it may be recharged (a few seconds to refill with gas versus several hours to recharge batteries); its smaller size and weight; its lack of any fire risk, electrical danger or radio interference; its avoidance of the use of toxic or dangerous chemicals as in lead-acid and other batteries; its low cost of manufacture and of operation; its controllability of speed and power; and its ability to use safe natural gases (i.e. as found in the clean atmosphere) which, after use, are returned back to the atmosphere without pollution.

Suitable liquefied gases for use with the motor may be classified into two distinct categories; those which at normal temperatures may be liquefied by pressure alone (for example carbon dioxide); and those such as nitrogen which must be cooled below normal atmospheric temperatures before liquefaction is possible even under pressure. Gases of the latter category must be stored in well-insulated tanks if they are to remain in the liquid state. Gases of the former category do not require to be kept cold in order to remain liquid and are therefore more easily handled and stored in the liquid state, which confers advantages of compactness, design simplicity and convenience.

BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described by way of example with reference to the accompanying drawings of which:

FIG. 1 is a longitudinal cross-section of a stored energy motor according to the invention, which motor has an integral liquefied gas tank;

FIG. 2 is a transverse cross-section on line X—X of the gas tank;

FIG. 3 is a transverse cross-section on line Y—Y showing the rotor and vanes used to expand and extract power from the gas.

FIG. 4 is a longitudinal cross-section of a gas supply apparatus according to the invention incorporating means to increase motor power, reduce gas consumption and to stabilise and control gas pressure.

FIG. 5 is a longitudinal cross-section of gas supply apparatus according to the invention containing a disposable supply bulb such as a "Sparklets" bulb.

FIG. 6 is a longitudinal cross-section of an adaptor suitable to adapt known types of existing model CO_2 motors to fit the gas supply apparatus shown in FIG. 5.

FIG. 7 is a view in elevation of a typical existing model CO_2 motor.

DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to FIG. 1, the motor has a tank (or vessel) 33 which is defined by shaped coupling members 16 and 34 in screw threaded engagement with a sleeve 35 of good heat-conductive metal. To enable it to be charged with liquefied gas the motor has a fill nozzle 1 whose lower end (as shown) is mounted in the coupling member 16 in a passage (or opening) 36 which communicates with the interior of the tank 33 by way of an orifice 3. The internal surface of the nozzle 1 has a frustoconical surface 4 which acts as an upper valve seat engaging elastomeric plug 2.

At the lower end (as shown) of the passage 36 is a lower frusto-conical valve seat 9 engageable with the plug 2 to seal from the tank a gas space 10 of chosen volume relative to that of the tank in communication with the passage 36 by way of a second orifice 8. The gas space is defined between one end of the coupling member 16 and one end of the cylindrical body of the motor, the coupling member 16 and body 11 being held in engagement by a sleeve 12 of heat conductive metal.

To charge the tank 33 with, say, liquid carbon dioxide, a refill cylinder (not shown) containing liquid CO_2 is applied to the nozzle 1 whereupon the plug is forced downwards into engagement with the lower valve seat 9 to place the tank 33 in communication with the nozzle 1. Liquid CO_2 thus flows into the tank 33 but not the gas space 10. The refill cylinder may be of conventional design. For example, it may operate in precisely the same manner as a butane cylinder for refilling cigarette lighters.

On withdrawing the refill cylinder, the plug 2 is returned by differential gas pressure to engage the upper valve seat 4. Because of the provision of the gas space 10 the motor is able to be constructed such that it complies with international legislation governing containers of compressed or liquefied gas. This legislation requires that not more than approximately 75% of the internal volume of the tank and motor assembly should be taken up by liquid CO_2, at 60° F. The remaining 25% is to be reserved for free gas space in order to accommodate expansion effects in hot climates. Thus, the ratio of volume of the gas space to that of the tank may be, for example, 25:75. When the charging is complete the required maximum permissible ratio of 75% liquid to 25% gas will thus not be exceeded.

As shown in FIG. 1, the sleeve 35 has a circumferential recess 37 in its outer surface. An outer sleeve of good heat conductive metal engages the outer surface of the (inner) sleeve 35 to define a closed cavity or (jacket) 38 for buffer substance 7.

When the jacket 38 is charged with the buffer substance (usually water) a small air space is left (see FIG. 2) to accommodate temperature-expansion effects. Elastomeric sealing rings 39 and 40 are engaged between the sleeves to prevent leakage of the buffer substance.

Saturated vapour evaporating from the tank 33 passes into the passage 36, through the orifice 8 and into the gas space 10. It then enters a passageway 13 which is defined between the body 11 of the motor and the sleeve 12. The sleeve 12 is in screw-threaded engagement with one end of the coupling member 16 and with one end of the body 11. The passageway 13 is helical and relatively long and narrow being defined between the screw threads on the sleeve 12 and those on the body 11, these screw-threads being suitably truncated. The adjacent ends of the body 11 and the coupling member 16 are spaced longitudinally apart from one another by a small distance to provide an entry for the vapour into the helical passageway 13.

The vapour enters the passageway 13 as shown by arrows 14 and makes its way to the motor via a needle control valve 15 and in doing so is heated to a temperature close to that of the sleeve 12 and the body 11 which, in the region of the engaging threads, are the warmest parts of the motor. The gas also experiences a loss in pressure due to frictional pressure drop in the helical passageway 13 and this, combined with the gas temperature rise, provides the gas with an adequate degree of superheating.

The coupling member 16 is preferably made of insulating material such as glass-reinforced nylon, so that the sleeve 12 and cylindrical body 11 are not cooled by thermal communication with the colder tank. In order to enhance further the degree of superheating, the sleeve 12 is provided with a plurality of fins 18 which link with a metallic shroud 17 which serves as a heat collector. The motor has a shaft 19. If the shaft is provided with a small fan or propellor in order to induce a flow of air over the motor shell with its fins and shroud, the temperature of the metal around the passageway 13 will closely approach that of the ambient air and thus impart to the CO_2 gas a temperature close to ambient.

An alternative method of enhancing the degree of superheating comprises the provision of a cavity or jacket around the shell in a way similar to that shown in FIGS. 1 and 2 for the tank. In this case a buffer substance is chosen for the cavity around the motor shell so that its buffering temperature is equal to or slightly above the superheat temperature desired. Thus, for instance, one could have a tank buffered at 0° C by means of a water jacket and the motor buffered at 16° C by means of an acetic acid jacket.

The shaft carries a vaned rotor shown in FIG. 3. The rotor comprises a conventional design in which a plurality of vanes 21, advantageously made of oil-filled polyethylene plastic (injection moulded), slide in slots in the rotor 22 which may advantageously made by injection moulding of oil-filled acetal resin (or vice versa). The body 11 of the motor has an eccentric bore 23 defining a chamber for the rotor 22. The vanes 21 are spring-loaded outwards in the eccentric bore 23 of the body 11 either under the action of vane springs 24 or by gas pressure fed via suitable small bleed holes (not shown) to the inward edge of the vanes 21.

The superheated gas, having first been throttled to a greater or lesser degree by the adjustable needle control

valve **15**, enters the chamber **23** via an inlet port **25**, drives the vaned rotor as it expands, and finally exhausts via port **26**.

Prevention of escape of gas across the faces of the vaned rotor may be achieved by the provision of two-face sealing discs **29**, of relatively soft and low frictional material such as PTFE or oil-filled polyethylene, which are pressed against the faces of the vaned rotor by means of an 'O' ring **30** or other compressible part such as a spring or spring-washer. The peripheries of the faces of the Rotor **22** preferably are provided with slightly raised rims (similar to the rims of coins) which wear into the face sealing discs and so inhibit the escape of gas across the faces of the vaned rotor. The 'O' ring **30** also prevents escape of gas sideways from the periphery of the vaned rotor assembly (where it meets the eccentric bore **23**) and also being initially compressed, expands as wear occurs in the vaned rotor and face sealing discs so as to take up that wear and prevent gas leakage paths paths from developing.

Higher motor powers and greater energy storage for a given amount of working fluid and buffer substance, and greater control and constancy of pressure and motor power as the tank is emptied, is achievable by the alternative tank assembly shown in FIG. **4**. This design is of value in the larger-power and longer-duration-power applications such as lawn mowers, moped motors and light automotive motors, and in applications requiring higher power-to-weight ratios and lower gas consumption such as airborne power devices; it is described as follows:

A buffer substance **133** is held in a container **134** preferably of metal of high thermal conductivity and low weight such as aluminium alloy or magnesium alloy. The container, or a part thereof, has integral therewith an extension at one end which is in the form of a yoke **135**. The yoke **135** has on its inner surface a step **146** and therefore has cylindrical portions **136** and **148** of narrower and wider bore respectively. Inside the yoke **135** and preferably closely-fitting with, and frictionally engaging, the portion **136** of narrower bore so as to provide good thermal communication with the yoke **135** is a metal block **137** (or other form of thermal pick-up) which can be translated along the axis of the yoke **135** in to positions in which its outer surface makes greater or less physical contact with the inner surface of the yoke **135**. By this means the surface area of the boundary across which heat may flow from the yoke **135** to the metal block **137** (which is preferably also of metal of high thermal conductivity) can vary from zero up to a maximum as the metal block moves leftward in FIG. **4**. Any radial clearance between the metal block **137** and the yoke **135** may advantageously be filled with a grease of high thermal conductivity, (for example silicone grease having zinc oxide dispersed therein) in order to improve heat flow.

The metal block acts as a bearing for one end of a rod of material of high thermal conductivity or a heat pipe **140** which extends leftward (as shown) through a flexible diaphragm **138** and a wall **147** integral with part of a tank **139**, into the tank **139** itself. The diaphragm has an inner marginal portion **149** held in engagement between the heat pipe or rod **140** and the metal block **137** and an outer marginal portion **150** held in engagement between the wall **147** and the leftward (as shown) face of an inward projection **151** from a hollow generally cylindrical coupling member **144** in screw-threaded engagement with the tank **139**. Liquefied gas is able to pass through an aperture in the wall **147** through which the heat pipe (or rod) **140** extends and thereby the diaphragm **138**, in effect, acts as a closure or wall of the tank.

The leftward end (as shown) of the heat pipe (or rod) **140** is supported in a linear bearing **141** forming part of a coupling member **116**, so that the heat pipe (or rod) may be translated leftward or rightward. A region of that part of the heat pipe (or rod) that is in the tank **139** has a plurality of fins **145** which may be axial or radial as shown in FIG. **4** and which extend into the liquefied gas in the tank **139**. This arrangement facilitates flow of heat from the heat pipe (or rod) **140** into the tank **139**.

Around the heat pipe **140** in the tank **139** is a compression spring **142** so arranged as to apply a leftward force on the heat pipe assembly, and scaled so that when gas pressure in the tank is at the desired level the metal block **137** is approximately in the position shown in FIG. **4**.

The yoke **135** advantageously has an external thread **143** which engages a complementary internal thread of the coupling member **144**. The coupling member **144** is preferably of thermally-insulating material such as glass-reinforced nylon so as to prevent undesirable flow of heat from the container **134** to the tank **139**.

The engaging threads between the coupling member **144** and the yoke **135** allow the yoke **135** to be adjusted so as to provide greater or lesser thermal coupling between the inner surface of the yoke **135** and the metal block **137**. This allows external adjustment of the controlled gas pressure in the tank **137** and thus of the power of a motor which can be connected to the left hand end (as shown) of the coupling member **116** in a manner similar to that shown in FIG. **1**.

The function of the tank assembly shown in FIG. **4** in stabilising gas pressure will now be apparent as follows:

Any withdrawal of gas from the tank **139** will initially cause a slight fall in both the temperature and the pressure of the contained gas, and thus a fall in temperature of the left hand end of the heat pipe or metallic rod **140**. The control spring **142**, because of the said fall in tank pressure, will thus cause the heat pipe assembly to move leftward, increasing the thermal contact area between the metal block **137** and the yoke **135** which, being warmer than the now-cooling heat pipe assembly, will convey more heat into the heat pipe or metallic rod and thence via the fins **145** into the liquid gas, thus restoring and regulating its temperature and pressure and causing the diaphragm **138** to flex outwardly and return the heat pipe (or rod) rightwards (as shown).

An equal or greater advantage of this design of tank assembly is its ability to control the heat flow from a much larger store of heat. Thus, even if the buffer substance **133** is much hotter than the tank **139** and its contained liquid gas, heat flow into the liquefied gas will be regulated so as to maintain the desired gas pressure and not allow it to rise undesirably and cause a wasteful increase in gas consumption. The buffer substance may therefore be heated above ambient temperature before use, so as to store a greater amount of heat energy which, during later use, is tranferred to the working fluid and converted to useful energy in the motor.

In addition, the arrangement allows the generation of gas pressures much larger than would be achieved at ambient pressure and, provided that the motor has an adequate expansion ratio, this permits a marked reduc-

tion in gas consumption for a given power output, or a large increase in power output at the same gas flow.

To permit these greater amounts of heat storage it is desirable to pre-heat the buffer substance before use and this may be accomplished for instance by either an electric element or an electrical heating jacket **156** preferably fitted with a thermostatic cut-out. If intended as auxiliary power to an I.C. engine, the buffer container may be kept hot by means of the hot exhaust or other engine heat (eg the cylinder block). In all such cases it is usually desirable to thermally-insulate the tank and buffer container so that the stored heat does not leak away to the environment. Referring to FIG. **5**, a disposable supply bottle or bulb **201** containing CO_2 (shown partly emptied) and painted on its outside surface with a thermally-conducting paint has a small oil-soaked pad **202** positioned immediately on the inside of a closure diaphragm **203**. The supply bulb **201** is shown inserted in a holder **204** which is advantageously made of injection-moulded glass-reinforced nylon and which is provided with a lining **205** of metallic foam or mesh containing a first buffer substance **206** if the bulb contains 8g of CO_2, preferably which comprises approximately 2 grams of water.

The leftward end (as shown) of the holder **204** is provided with a female thread which engages with the male thread of a body member **207**, and this thread not only supports the holder **204** but also allows the closure diaphragm **203** to be punctured by a hollow piercing needle **208** when it is desired to energize the gas supply apparatus by increasing the engagement of the threads. The holder **204** is sealed against loss of the first buffer substance **206** by means of an 'O' ring **209** and the neck of the supply bulb **201** is sealed against leakage of the CO_2 after puncturing by means of an 'O' ring **210** about the neck of the bulb **201**. The piercing needle **208** is held in the body member **207** by means of a nut **211** and sealed by an 'O' ring **212** and soldered to a superheater tube **213** which is coiled within a superheater chamber **214** and which terminates with a soldered connection to a probe **215**.

The superheater chamber **214** in this embodiment is housed between an end member **229** and the lefthand end face (as shown) of the body member **207**. In this embodiment it may contain 1.5 grams of 99% glacial acetic acid/1% water (by volume) which comprises a second buffer **216** and which assists the superheating process to a vapour temperature of approximately 10° C. A coil retainer **217** in the form of a disc of plastic sheet (such as "Cobex" R T M PVC sheet) serves to contain the coils of the superheater tube **213**. The probe **215** is provided with 'O' ring **218** and is pressed into a housing **219** after the application of an adhesive sealant such as "Loctite" (R T M). The probe housing **219** is itself pressed and sealed into the end member **229** either using "Loctite" (R T M) or possibly by moulding it into the end member **229** which, together with the body member **207**, may advantageously be injection moulded in glass-reinforced nylon or acetal resin or similar plastics resistant to acetic acid. The superheater chamber may be sealed against loss of the second buffer **216** by means of an 'O' ring **220** or alternatively sealed to the body member **207** by an adhesive sealant or by spin or friction welding. All metallic parts in contact with the second buffer **216** are desirably made of aluminium or stainless steel or electro-plated mild steel when acetic acid is used; copper and copper containing metals such

as brass are likely to corrode and are not therefore recommended.

Referring to FIG. **6** and FIG. **7** it will be seen that the motor is provided with a mounting flange **221** and mounting screws **222**. The adaptor shown in FIG. **6** is so designed to marry with this mounting flange **221** and is provided with tapped attachment holes **223** positioned so as to accept the mounting screws **222** as indicated by the dashed lines, and thereby to allow the adaptor to be fixed to the motor. The leftward end (as shown) of the adaptor is provided with a socket **224** sized to take an inlet feed pipe **225** of the motor by means of a soldered connexion. The rightward end (as shown) of the adaptor is provided firstly with a male thread **226** which engages with a female thread in the leftward end (as shown) of the housing **219** shown in FIG. **5** so as to allow the motor plus adaptor to be quickly attached to the probe, and secondly with a chamfered socket **227** which is designed so as to accept the probe **215** and at the same to compress and seal the 'O' ring **218** of the end member in FIG. **5**.

The oil-soaked porous pad **202** enables the issuing gas from the supply bulb **201** to carry with it droplets of oil into the motor. This technique is particularly useful where disposable supply bottles such as "Sparklets" bulbs are used, as on each occasion that a fresh supply bottle is slipped into the gas supply apparatus and used, the motor will receive fresh lubrication at the beginning of the run.

I claim:

1. A motor having in combination therewith apparatus for supplying to the motor gas evaporated from liquefied gas, said apparatus comprising a vessel containing liquefied gas, a passage which affords communication between the vessel and the motor whereby gas evaporating from the liquefied gas is conducted into the motor, and in heat conductive relationship with the vessel, at least one container holding a buffer substance which during operation of the motor releases heat to the vessel and the liquefied gas therein, whereby the tendency of the evaporation of the liquefied gas to cool the remaining liquefied gas in the vessel is at least partly counteracted.

2. A motor according to claim **1**, in which the buffer substance is contained in a jacket surrounding the vessel.

3. A motor according to claim **1**, in which the said container is located in the vessel.

4. A motor according to claim **1**, in which the vessel has associated therewith means for pre-heating the substance.

5. A motor according to claim **1**, additionally including manually operable means for placing the passage in communication within the vessel.

6. A motor according to claim **1**, in which the buffer substance is a liquid which freezes at a temperature between ambient temperature and the final operating temperature of the liquefied gas.

7. A motor according to claim **1**, in which the passage has means for causing the evaporated gas to undergo a pressure drop of more than 10% of the saturation pressure of the liquefied gas at the prevailing temperature of the liquefied gas in the vessel, whereby the speed of the motor is able to be stabilised.

8. A motor according to claim **7**, in which there is at least one secondary container holding buffer substance in heat conductive relationship with at least part of the said passage.

9. A motor according to claim 8, in which the buffer substance in the said secondary container is a liquid which on freezing releases heat to evaporated gas flowing through the passage, and which has a freezing point between ambient temperature and the temperature of the evaporated gas entering the passage, and in which the buffer substance in the said container in heat conductive relationship with the vessel is a liquid which on freezing releases heat and which has a freezing point between ambient temperature and the temperature of the liquefied gas in the vessel, the buffer substance in the secondary container having a freezing point greater than the freezing point of the buffer substance in the said container in heat conductive relationship with the vessel.

10. A motor having in combination therewith apparatus for supplying to the motor gas evaporated from liquefied gas, said apparatus comprising a vessel containing liquefied gas, a passage which affords communication between the vessel and the motor whereby gas evaporating from the liquefied gas is conducted into the motor, and, in heat conductive relationship with at least part of the passage at least one container holding a buffer substance which during operation of the motor releases heat to evaporated gas as it passes through the passage thereby raising the temperature of said evaporated gas.

* * * * *

United States Patent [19]

Rilett

[11] **4,224,799**

[45] **Sep. 30, 1980**

[54] **GAS-OPERATED MOTOR SYSTEMS**

[76] Inventor: **John W. Rilett**, 18 Links View, Stratton, Cirencester, Gloucestershire, England

[21] Appl. No.: **925,398**

[22] Filed: **Jul. 17, 1978**

[30] **Foreign Application Priority Data**

Jul. 16, 1977 [GB] United Kingdom 29987/77

[51] **Int. Cl.**[3] **F01K 25/10**

[52] **U.S. Cl.** **60/671**; 60/685

[58] **Field of Search** 60/651, 671, 685, 650, 60/682

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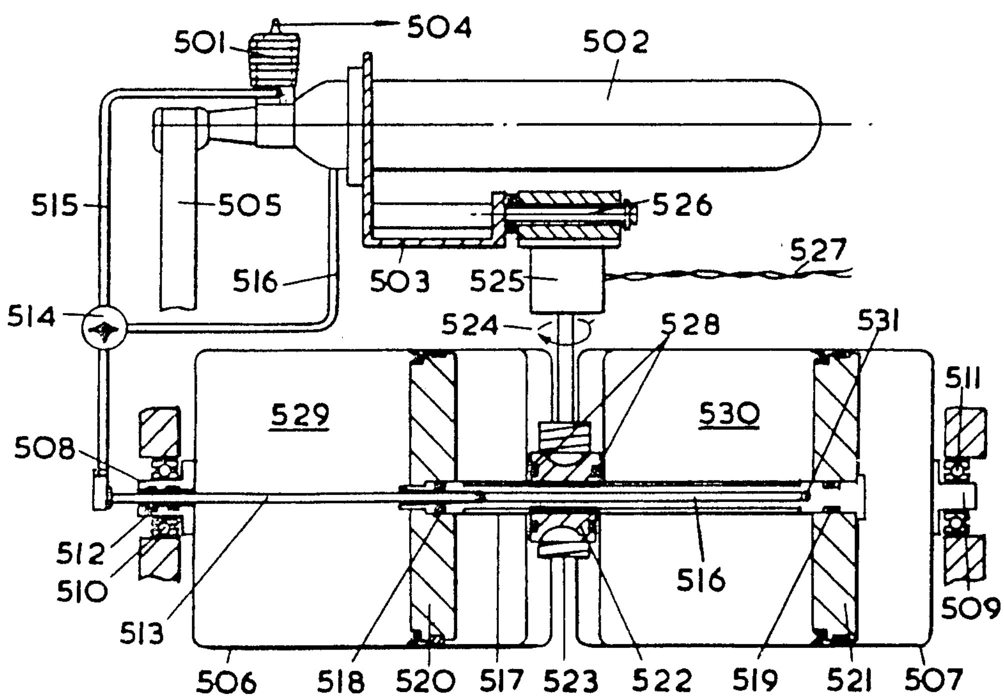
Primary Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—Dennison, Dennison, Meserole & Pollack

[57] **ABSTRACT**

A gas-operated motor system of the stored energy type—as disclosed in U.S. Pat. No. 4,092,830—in which the gas exhausted from the motor is ducted to a chamber during operation of the motor and thereafter compressed back into the gas reservoir vessel. Recompression may be achieved e.g. by providing the exhaust gas chamber with a movable piston, or by running the motor in the reverse mode as a compressor.

10 Claims, 3 Drawing Figures



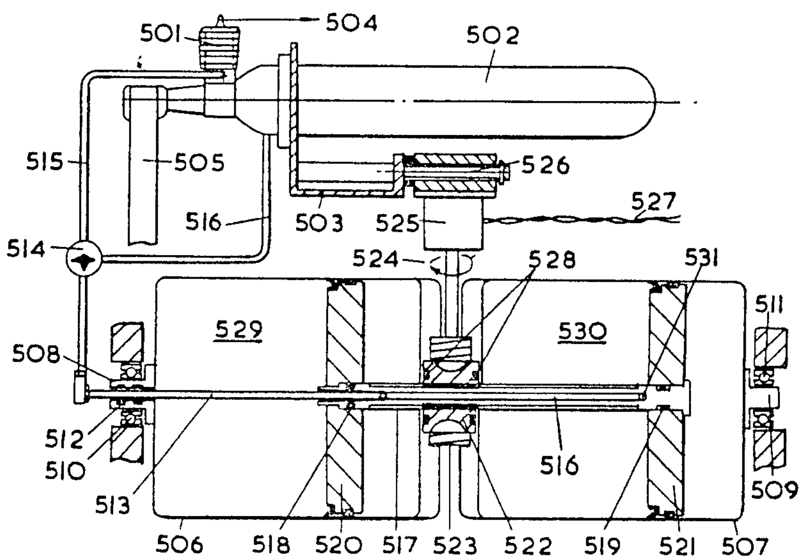

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FIG. 1

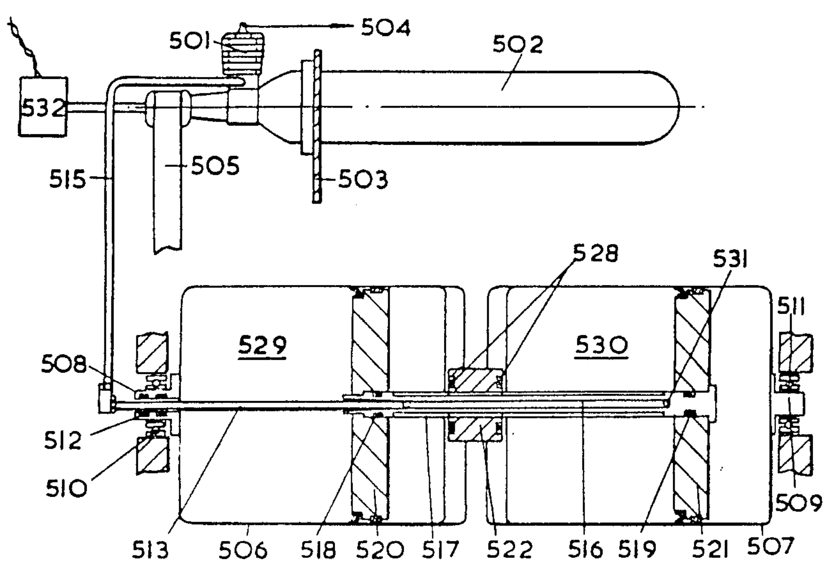
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FIG. 2

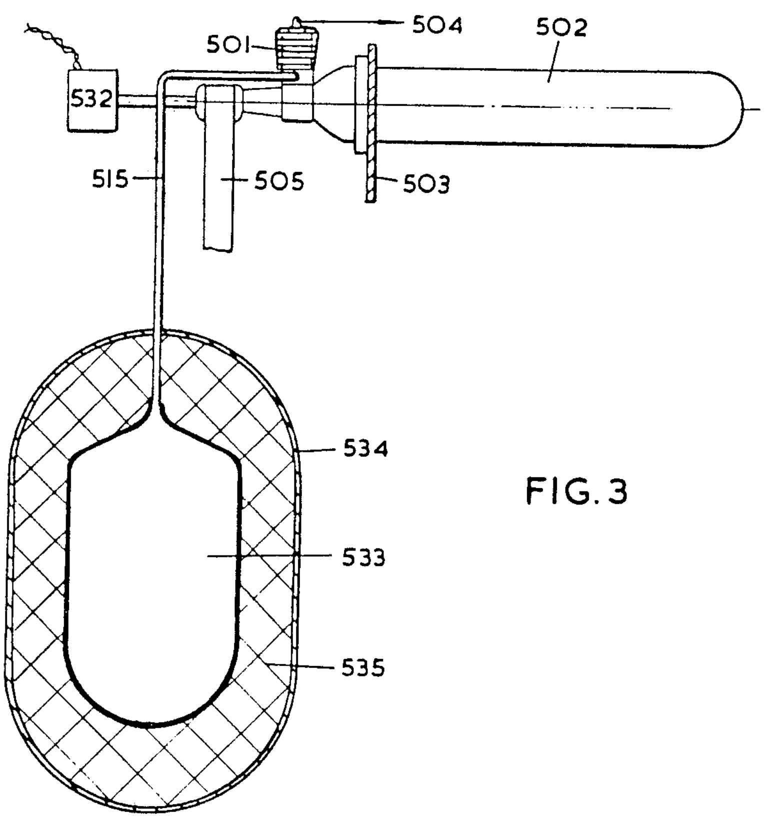

FIG. 3

GAS-OPERATED MOTOR SYSTEMS

FIELD OF THE INVENTION

The present invention relates to gas-operated motor systems wherein the motor is driven by the pressure of a non-combusting gas, for example carbondioxide. More particularly the invention is concerned with stored energy gas-operated motor systems which term, for the purpose of this specification, is defined as a system comprising a gas-operated motor, a reservoir vessel adapted to contain gas or a gas/liquefied gas mixture under pressure, a passage for the supply of gas from said vessel to the working chamber or chambers of the motor, and a container holding or capable of being charged with a buffer substance in heat conductive relationship with said vessel and/or passage thereby to provide heat to the gas prior to its expansion in the motor. Such systems are described in my U.S. Pat. No. 4,092,830, to which reference is directed for a full discussion of the merits of employing buffer substances in conjunction with the gas supply means of such systems.

BACKGROUND AND SUMMARY OF THE INVENTION

The references mentioned above describe stored energy gas-operated motor systems in which the working fluid, after passing through the motor, is exhausted to atmosphere. Such practice is satisfactory in applications where the gas usage is low but there are other applications, such as in the larger control-line and radio-controlled model aircraft, lawn mowers, fork-lift trucks and so on up to significantly higher powers and energy capacities, in which it becomes economically desirable to re-use the working fluid.

The present invention accordingly provides a gas-operated stored energy motor system including means for ducting the gas exhausted from the motor to a chamber during operation of the motor, and means for recompressing the exhaust gas from said chamber into the reservoir vessel.

The chamber to which the exhaust gas is ducted may be, for example, defined by a cylinder provided with a movable piston which can be driven by separate motor means to recompress the exhaust gas from the chamber into the reservoir vessel. In another preferred embodiment, however, the gas-operated motor is itself additionally adapted to be driven, by separate motor means, in the reverse mode—i.e. as a compressor—to return the exhaust gas to the reservoir vessel.

The invention will now be more particularly described with reference to the accompanying drawings in terms of its application to use in a lawn mower. This is but one example of the many suitable uses to which the invention may be put, and is for the purpose of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows schematically, part in elevation and part in cross section, one embodiment of the invention as applied to a lawn mower; and

FIGS. 2 and 3 are similar views of two other embodiments.

Like parts are denoted by like reference numerals throughout the drawings.

DETAILED DESCRIPTION OF THE DRAWINGS

Throughout the following description, all pressures mentioned are gauge pressures.

Referring to FIG. 1, reference numeral **501** denotes a gas-operated motor of typical power 100 to 200 watts and reference numeral **502** denotes a power capsule incorporating a buffered gas supply reservoir of capacity typically 500 to a 1000 grams (in the case of CO_2 as the working fluid) mounted on a frame member **503** of the lawn mower.

A toothed belt **505** or other suitable transmission device couples the motor drive shaft to two hollow rollers **506** and **507** and also if necessary to the rotary, cylindrical or other cutter of the lawn mower (not shown). The rollers are provided with journals **508** and **509** supported in bearings **510** and **511** in the mower frame. The lefthand journal **508** (as viewed in the Figure) has a central hole sealed by O-rings **512** or other suitable sealing devices onto a fixed torque tube **513** which is connected via a valve **514** and pipe **515** to the exhaust gas outlet of the motor **501**. The torque tube **513** fits inside (but not in a gas-tight manner) the central bore **516** of a lead screw **517** which is provided with an internal groove engaging with an asymmetric protuberance (not shown) on the torque tube so as to prevent rotation of the lead screw whilst permitting axial movement of the screw relative to the torque tube. The two ends of the lead screw are provided with sealed journals **518** and **519** carrying pistons **520** and **521** which may rotate relative to the lead screw but are prevented from axial movement relative thereto. The lead screw passes through an internally threaded member **522** which constitutes also a worm wheel engagable with a worm **523** which can be driven in the direction of the arrow **524** by an electric motor **525** (which may have a power of typically 10 to 30 watts) supplied through mains leads **527** which are disconnected when the lawn mower is in use. The electric motor **525** is rotatably supported for instance on a spindle **526** and has provision (not shown) whereby it may be swung in or out so as to engage or disengage the worm from the wheel. The wheel **522** is provided with sealing rings **528** which seal its two faces against the adjacent surfaces of the rollers **506** and **507** so as to allow slightly resisted relative rotation of the two rollers (to facilitate turning corners when mowing) whilst preventing gas loss therefrom.

During lawn mowing the gas which exhausts from motor **501** is ducted through pipe **515**, valve **514** and torque tube **513** into the bore **516** of the lead screw. From the bore **516** the gas passes into the two sealed chambers **529** and **530** which are defined within the rollers **506** and **507** to the left (as viewed) of the pistons **520** and **521** respectively. Gas flow to chamber **529** is afforded by the clearance which exists between the exterior of the torque tube and the bore **516** at its left-hand end, and gas flow to chamber **530** is afforded by a crosshole **531** provided at the opposite end of the bore. As the rollers are rotatably driven by the motor the friction fit between the rollers and wheel **522** likewise causes the latter to rotate, in so doing the threaded connection between member **522** and the non-rotating lead screw **517** being effective to drive the lead screw and pistons **520**/**521** slowly to the right. The movement of the pistons gradually increases the volumes of the chambers **529** and **530** so as to maintain an approximately constant exhaust pressure in the region of 10 to

20 atmospheres. The power capsule **502** is buffered to give a motor supply gas pressure in the region of 40 to 60 atmospheres, so a motor of expansion ratio of only 3:1 or thereabouts will suffice, allowing the motor to be small.

After lawn mowing the worm **523** and wheel **522** are engaged, the electric motor **525** is connected and switched on, and the valve **514** switched to direct the gas flow from the rollers to the power capsule **502** via the branch pipe **516**. The worm is effective to rotate the wheel in the direction opposite to that which pertains during lawn mowing, whereupon the lead screw and pistons **520/521** move slowly leftward, recompressing the gas from the chambers **529** and **530** into the power capsule where it condenses (if CO_2) with help from the power capsule's buffer (now frozen) and from natural heat loss to the environment. The power capsule is safety-valved at perhaps 2000 psi (with a burst pressure of perhaps 5000 psi) which will permit recompression of the CO_2 at temperatures as high as 100° C. or more, though natural heat loss, and design—by use of a buffer having a freezing point of typically 20° C.—should limit this temperature to a much lower figure and permit ultimate condensation of the CO_2 when below its critical temperature of 31° C. Recharging of the power capsule in this way may take one to two hours with the small electric motor described but, with a more powerful electric motor and suitable design, this recharge time may be reduced considerably.

Turning now to FIG. **2** this shows an alternative embodiment which dispenses with the need to provide the worm **523** and a mechanism for latching it in and out of engagement with the member **522**, the external toothform on member **522**, valve **514** and branch pipe **516**. Instead, the electric motor for use in recharging is sited at **523** and arranged to drive the motor **501** in the reverse mode so that it acts as a compressor to return exhaust gas from chambers **529/530** back to the power capsule **502**. By this means not only is a simplification in the number of required components obtained, but also since the work of compressing the gas back into the power capsule is taken over from the pistons **520** and **521** by the motor/compressor **501**, the rollers **506** and **507** become safer and easier to manufacture as they then require to sustain a pressure of only 10 to 20 atmospheres. Whilst being driven backwards as a compressor, the "motor " will of course in addition drive the pistons **520** and **521** leftwards, encouraging the return flow of the working fluid and maintaining the inlet pressure to the compressor at a sensibly constant level. Furthermore in the event of gas leakage past the piston of the compressor, the pistons **520** and **521** will automatically restore the gas feed into the compressor. While the motor is operating to recompress the exhaust gas into the power capsule the buffer substance performs the valuable function of absorbing heat from the gas in addition to the buffer substance(s) in the power capsule.

A further simplication of the arrangement shown in FIG. **2**, whereby the pistons **520** and **521**, lead screw **517**, member **522**, torque tube **513** and the several seals associated with these parts may be dispensed with, will now be described with reference to FIG. **3**. In this embodiment, the exhaust pipe **515** leads to a sealed bag **533** designed to be able to swell (being made of an elastomeric material, or as a bellows preferably with a return spring or other cushioning device to squeeze the bellows, or in other known ways known generally as 'pneumatic accumulator') as it receives exhaust gas from the motor **501**, and to squeeze the gas to flow in the reverse direction back to the motor when the latter is operating as a compressor. Such an arrangement is particularly suitable if the working fluid is a halocarbon such as one of the FREONs (registered trademark), or a similar substance operating at lower pressures than a CO_2 working fluid (e.g. at 0–10 atmospheres) and which may partially condense in the sealed bag.

The sealed bag may if appropriate be contained within an outer chamber **534** and the space between the sealed bag and the outer chamber may be advantage be partially or completely filled with an insulating material **535** such as polyurethane foam which is also compressible as the bag swells and which may also advantageously be particulate, for instance being in the form of many small soft polyurethane foam rubber balls. The purpose of such compressible insulation is to prevent heat flow into the exhaust gas (which may be at a temperature typically of 0 to −30° C. depending on the choice of working fluid) from the surroundings and so to reduce the work done in subsequent compression and to reduce the temperature of the power capsule during that compression. Alternatively the space between the sealed bag and the outer chamber (or between the outer chamber and a further jacket surrounding it) may be evacuated and possibly mirror-surfaced in the known manner of vacuum insulated vessels, again in order to prevent heat flow from the surroundings into the gas.

I claim:

1. A fluid pressure operated motor system comprising: a fluid pressure operated motor; a reservoir vessel adapted to contain pressurized fluid; a passage for the supply of pressure fluid from said vessel to a working chamber of the motor; a container holding a buffer substance in heat exchange relationship with said pressure fluid; an exhaust chamber arranged to receive the pressure fluid exhausted from the motor during operation thereof; and means for recompressing the exhaust from said exhaust chamber back into the reservoir vessel when said motor is not performing a work output function.

2. A system according to claim **1** wherein said working chamber is defined by a cylinder provided with a movable piston, and comprising further motor means for driving said piston to recompress the exhaust from the working chamber into the reservoir vessel subsequent to operation of the fluid pressure operated motor.

3. A system according to claim **2** wherein said piston is arranged to be driven by the fluid pressure operated motor to increase the volume of the exhaust chamber available to receive exhaust during operation of the fluid pressure operated motor.

4. A system according to claim **1** wherein the fluid pressure operated motor is further adapted to be driven as a compressor; and comprises separate motor means for driving the fluid pressure operated motor as a compressor to recompress the exhaust from said exhaust chamber back into the reservoir vessel subsequent to operation of the fluid pressure operated motor as a motor.

5. A system according to claim **4** wherein said exhaust chamber is defined by a cylinder provided with a movable piston and the piston is arranged to be driven to decrease the volume of the chamber available to retain exhaust during operation of the fluid pressure operated motor as a compressor.

6. A system according to claim **4** wherein said exhaust chamber is expansible against a resilient bias under

the pressure of exhaust fed to it from the fluid pressure operated motor.

7. A system according to claim **1** wherein said exhaust chamber is thermally insulated from it surroundings.

8. A system according to claim **1** wherein it is arranged that the exhaust gas partially condenses in said exhaust chamber.

9. A system according to claim **1** wherein said buffer substance aborbs heat from the exhaust gas during said recompression thereof.

10. A system according to claim **4** comprising a container charged with a buffer substance in heat exchange relationship with the working chamber of the motor and to heat the pressure fluid during expansion in the motor and to absorb heat from the exhaust during said recompression thereof.

* * * * *

United States Patent [19]

Leibow et al.

[11] **4,208,592**

[45] **Jun. 17, 1980**

[54] COMPRESSED AIR POWER GENERATING SYSTEM

[76] Inventors: **Baruch Leibow; Isaac Leibow,** both of Hashilowach St., #16, Haifa, Israel

[21] Appl. No.: **940,378**

[22] Filed: **Sep. 7, 1978**

[51] **Int. Cl.**² **H02K 7/18**

[52] **U.S. Cl.** **290/52**; 60/407; 322/35; 417/411

[58] **Field of Search** 290/52, 54, 43, 44; 322/35, 38, 40; 60/407, 412, 410, 419; 417/411

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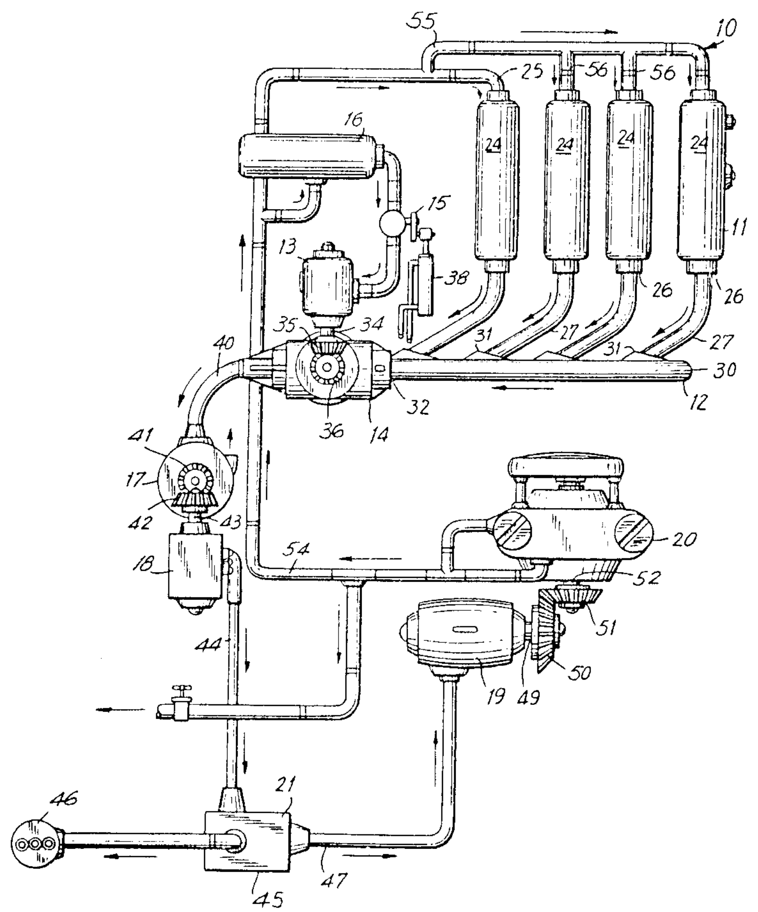
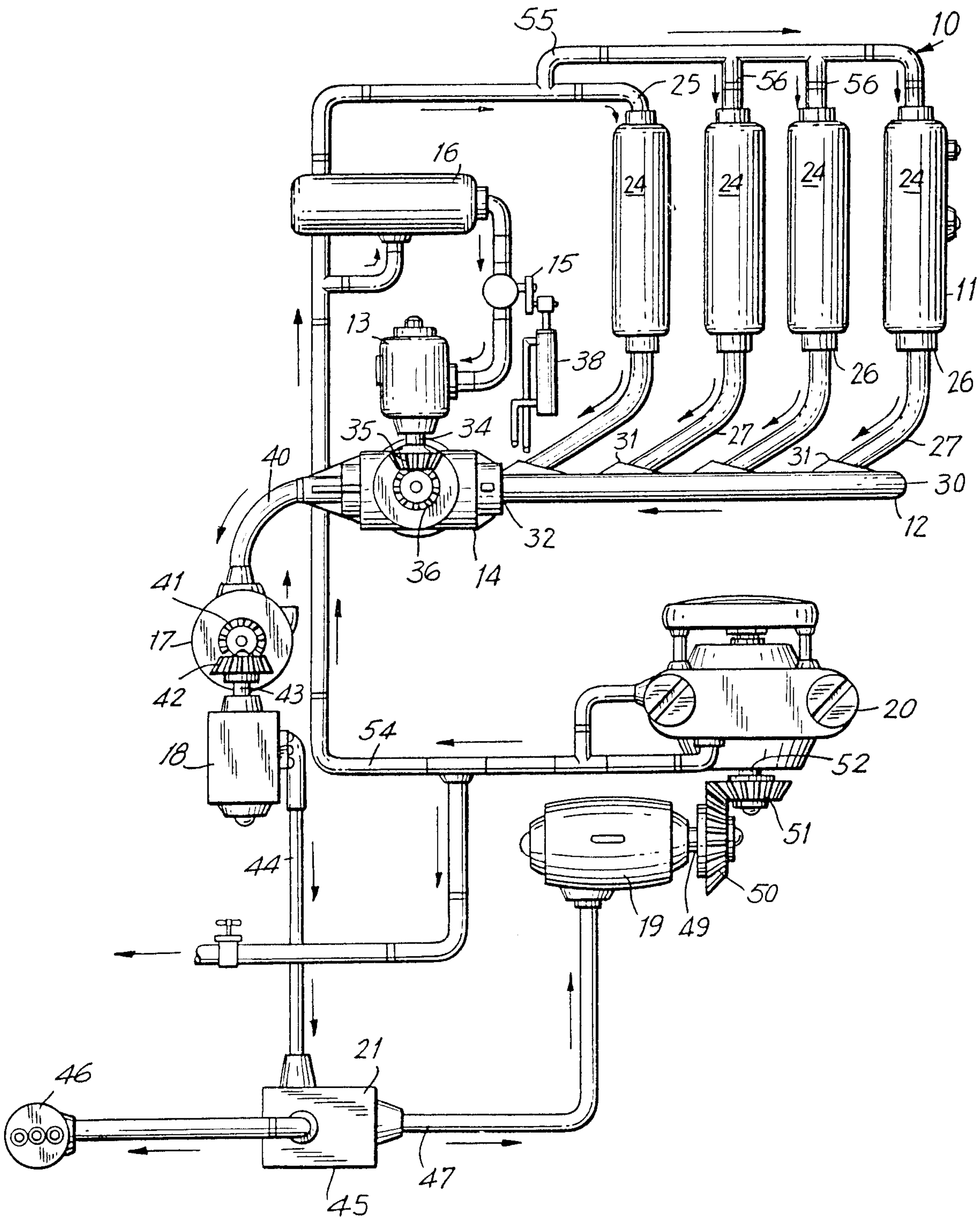
Primary Examiner—J. V. Truhe
Assistant Examiner—Morris Ginsburg

[57] **ABSTRACT**

A system for converting compressed air to motive power for generating electricity, a part of the output being used to partially recharge an initial compressed air source, thereby permitting the device to operate for extended periods without an external source of energy.

3 Claims, 1 Drawing Figure

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COMPRESSED AIR POWER GENERATING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates generally to the field of electric power generation, and more particularly to an improved form of small generating plant adapted to operate for relatively extended periods of time in the order of several hours without other than an initial charge of compressed air as an energy source. Such devices are particularly useful in specialized applications where petroleum fuels and the like are not readily available or usable.

Motors and turbines operating from power generated by expanding gasses are well known in the art, such devices normally employing combustible fuels in either liquid or gaseous form. The use of compressed air motors for a variety of functions is also known.

Where a constant energy source is continuously supplying a compressed or expanding gas under pressure, continuous operation may be maintained without difficulty. However, when only a fixed individual charge of such gas is available, a constant diminution in pressure soon makes continuous operation of such devices impossible.

SUMMARY OF THE INVENTION

Briefly stated, the invention contemplates the provision of a compressed air system capable of generating electricity for extended periods of time using an initial charge of compressed air which is utilized in such manner that the devices using such compressed air ultimately compress small amounts of air under high pressure which is returned to the initial source, thus maintaining operational pressure for a longer period of time than would otherwise be the case. Devices of this type have application in specialized situations where the use of combustible fuels is not possible, but the requirement for continuous generated power is substantially greater from a time standpoint than is normally available from a fixed charge compressed air source.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, to which reference will be made in the specification, the FIGURE is a fragmentary schematic view of an embodiment of the invention.

DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENT

In accordance with the invention, the device, generally indicated by reference character **10**, comprises broadly: a rechargeable source of compressed air **11**, a compressed air manifold element **12**, an air powered stand element **13**, an air regulating sprayer element **14**, air valve means **15**, an auxiliary cylinder element **16**, an air turbine element **17**, an electrogenerator **18**, an electromotor **19**, a compressor element **20** and a power output junction **21**.

The chargeable source **11** includes a plurality of air cylinders **24** having charging inlets **25** and exhaust outlets **26** including conduits **27** feeding the manifold **12**.

The manifold **12** includes a closed end **30**, a plurality of inlet connections **31**, and a single outlet **32** leading to the sprayer element **14**.

The stand element **13** includes an air motor (not shown) having an output shaft **34** mounting a bevel gear **35** which drives a corresponding bevel gear **36** on the sprayer element **14**. The motor is powered from the auxiliary cylinder element **16** and controlled by the valve means **15** by means of a small air cylinder **38** and associated linkage. Means (not shown) controls the cylinder **38** such that with diminution of pressure in the source **11**, more air is fed from the auxiliary cylinder element **16** to enable the sprayer to distribute a greater flow of air to the turbine **17**, thereby maintaining a constant angular velocity in the latter.

Extending from the sprayer element **14** is a conduit **40** leading directly to the turbine **17**. The turbine drives through bevel gears **41** and **42** a shaft **43** on the generator **18**, the output of the same flowing over leads **44** to a junction box **45** having a power outlet **46**. Another set of leads **47** leads to the motor **19**, the output shaft **49** of which drives through bevel gears **50** and **51** and input shaft **52** of the compressor **20**. The compressor **20** is in the form of a positive displacement blower, and delivers a relatively small volume of air at a pressure substantially higher than the initial pressure in the source **11**. The output of the compressor is fed over conduits **54** and **55** to a return conduit **56** servicing the charging inlets **25** of the source **11**.

OPERATION

To commence operation, the cylinders comprising the source **11** are charged to approximately **12** atmospheres pressure. It is to be noted that the stand is separately driven by auxiliary cylinders and may operate on considerably lower pressure. The individual cylinders of the source **11** may be drained either serially, or in parallel, and in either event is regulated such that when pressure is relatively high, the air reaching the turbine is forced to move through more constricted passages. As pressure drops, the sprayer rotates more rapidly, enabling the air to more readily reach the turbine, thereby maintaining substantially constant velocity necessary to maintain a correspondingly constant output from the generator.

During operation, compressed air is continuously being supplied to the source **11** from the compressor, although it will be readily appreciated that because of the reduced volume available from the compressor, the pressure in the source will be continuously diminished, although at a much lower rate than would be the case if no replenishment of compressed air were available. During operation, a continuous flow of electrical energy may be drained from the junction box, and power output remains substantially constant, until the pressure in the source drops below that necessary to sustain operation of the turbine. Where roughly ⅓ of the available energy from the generator is extracted, the system can sustain itself for more than three hours of continuous operation. It can be recommenced by recharging the source **11** to its initial pressure.

To obtain the equivalent amount of operating time without partially restoring pressure in the source, the source itself would need to be many times larger than is otherwise necessary, and since pressure drop during operation would not be in a straight line, but a continuously diminishing curve, proper operation would be impossible while less than half of the available volume in the source is consumed.

I wish it to be understood that I do not consider the invention limited to the precise details of structure shown and set forth in this specification, for obvious

modifications will occur to those skilled in the art to which the invention pertains.

I claim:

1. An improved compressed air generating system comprising: a chargeable source of compressed air, air motor means driven from said chargeable source, means for regulating the flow of air from said source to said motor means for automatically maintaining substantially constant speed of said motor means during changes in pressure in said source, generator means driven by said air motor means, means for utilizing part of the electrical energy generated by said generator means for external power, an electromotor driven by a remaining part of said electrical energy, air compressor means driven by said electromotor, and means conducting the output of said air compressor means to said chargeable source.

2. A system in accordance with claim 1, further characterized in said air motor means being in the form of a turbine, and said regulating means being in the form of a rotary air sprayer in series with the flow of compressed air to said turbine, and sensitive to varying pressure in said chargeable source.

3. A system in accordance with claim 1, further characterized in said air compressor producing compressed air at a pressure above that in said chargeable source.

* * * * *

By staff writer JOHN ELDER
Photos by
PHIL BLATCH

UNDER PRESSURE

High costs, sceptics and heavies stand in the way of Des's air-engine breakthrough

ALL INVENTOR Des Hill wants is $10,000 — and a secret place to hide from "thugs, murderers, thieves, saboteurs and disbelievers" — so he can finish his life's work in peace.

He's going to solve the world's fuel and pollution problems by building a car engine that runs on air.

Des has already spent more than $200,000 and 30 frustrating years working on his miracle machine.

"With," adds the Sydney grandfather, retired motor mechanic and former speedway star, "death threats, scepticism and unbelievable harassment dogging every step I take toward success.

"I was once approached by a very heavy character — a big crim name in Sydney — who wanted to set me up in a factory, finance the completion of the machine and take over sole rights!" says Des. "I told him to bugger off.

"He then turned around and said he could get me bumped off for $2000.

"I told him that I had a bow and arrow and that I could hit a small target at 30 metres, and that it could open up his guts like a ripe tomato. He left without a word."

Des has spent all that time and money on the Desbea engine (named after Des and his wife Bea) with limited success, but claims he needs only $10,000 — plus 10 solid working days, a few specially made parts and a technically minded junior partner to do all the hard labour under close supervision — to develop a perfected working prototype.

According to the inventor, cars powered by the Desbea engine will have a cylinder of compressed air built into each front mudguard.

"One of the cylinders will act as a spare and will probably never be needed," says Des.

"The other cylinder will be connected to an air compressor — mounted on the side of the engine — on one end and to the injector system at the other end.

"The air compressor, which works while the engine is running, will ensure that the cylinder is filled to capacity at all times.

"Thus the Desbea engine, when perfected, will realise the principle of perpetual motion."

But how does the engine actually work? Des explains it like this:

- "The car's electrical system remains intact. The battery, generator and starter motor all work to turn the motor over in the normal way when you turn the ignition key.
- "Turning the ignition key automatically opens a valve, allowing compressed air from the cylinder to flow to the injector system.

Inventor Des says his air injector system can be up and running with a 'chickenfeed' $10,000 sponsorship.

- "The pressure opens the injectors, the first injection of compressed air is made and the motor is running. It's that simple. There's no coughing or stalling. The engine will start every time . . . unlike normal petrol engines.
- "The air pressure is directed to the pistons and is injected into them in a specially programmed sequence.
- "The pistons drive the motor and power the gearbox, through to the tail shaft to the differential, back axles and, in turn, to the wheels.

"I know that this works. All I need is a sponsor to help me complete my work. I believe that it won't even cost $10,000 . . . the investor is bound to get change out of it.

"And the possible returns are enormous. I had the engine valued on the world market. They gave me a conservative figure of four billion. Enough for everyone.

"Crickey, $10,000 is chicken-feed."

If he can't attract a sponsor from the public sector — and he's already tried the government, oil companies and car manufacturers without any luck — a tired and fed-up Des Hill will admit defeat and try to forget about the dream invention that could have made him rich and famous.

If he strikes out this time, says Des, the world can go and take a running jump and miss out on "one of the most important breakthroughs ever conceived."

Is there someone out there with the "right vision and courage" to help Des Hill?

Engineers and know-alls have told him his invention is impossible. It defies many basic engineering and mechanical principles, they say.

"They laugh at me and don't listen close to what I'm saying," says Des. "I've already had a number of motors running on compressed air. But no one believes it.

"Even when I've demonstrated a running motor to people, they refuse to believe their own eyes! It's crazy.

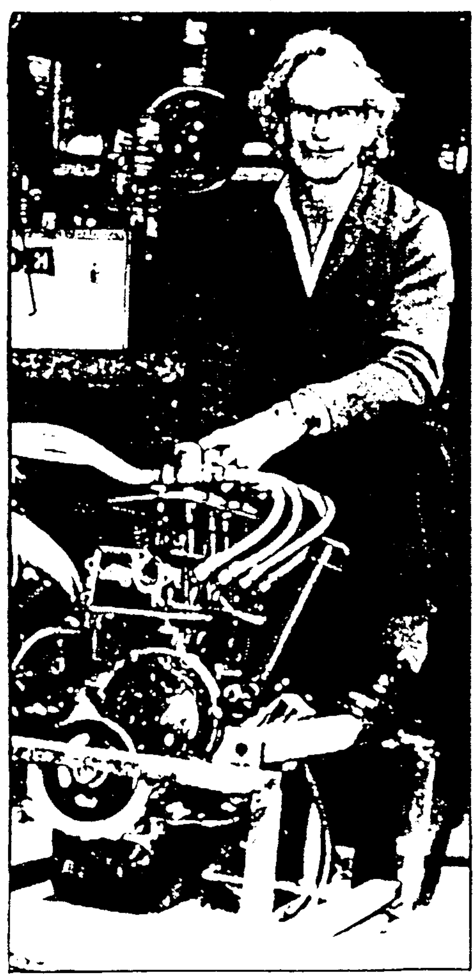
"First, I converted a Mazda truck to run on compressed air. It was crude, pretty violent, made one hell of a noise and was totally uncontrollable . . . but it worked.

"The power of the thing was unbelievable. Mind-blowing.

"Well, I had this thing going and I was set to show it off to the big car manufacturers, when the saboteurs hit for the first time.

"Some mongrel put steel shavings into the engine. That stuffed it beyond repair. I was shocked, angry and heart-broken. And I was ready to knock the stuffing out of whoever did it.

"But, there was no way I was going to stop. I got another engine going. Converted to air. Again, I was so close to perfection, when saboteurs hit again. Someone came into our backyard one night and pinched all the secret and vital parts off the motor. Those parts cost a lot of money to make. They were unique."



Just before he was to unveil a prototype air engine to the big car makers, Des says 'some mongrel' sabotaged it.

By this time he had gone broke as he had on several occasions But he persevered

"Working on a reduced budget, I converted a popular brand lawnmower to run on air Jesus Christ, did it go!

"Initially, we tested it on an artillery range and found that it could easily run up to 36,000 revs per minute, which is truly amazing

"I then tested the mower on the back lawn It worked brilliantly

"The next step was to take the converted machine to the mower manufacturer I was confident — convinced I had made a breakthrough

"The boss — the company's general manager — did his top He went berserk He told me that I had ruined a perfectly good petrol-fuelled machine His lawnmowers were meant to run on petrol He said I was a vandal

"He had no idea of the potential of my invention He threw me and my wife out the door. It was crazy

"Everywhere I go I run into obstacles I applied to the government for a development grant. They dismissed it out of hand calling the machine impossible

"The car companies, the motor transport departments and the defence authorities have claimed to be interested But they say I must finish my prototype before they are willing to come in with any investment.

"I thought my luck had changed a few years ago when I was allowed to appear on The Inventors TV show The station later apologised for screening what they considered to be something that would never work.

"I have put up with that kind of humiliation and disappointment and I have kept going because I want to contribute something important to the world "

Des is bitter when he thinks back to the days when he started out as an excited and naive young inventor.

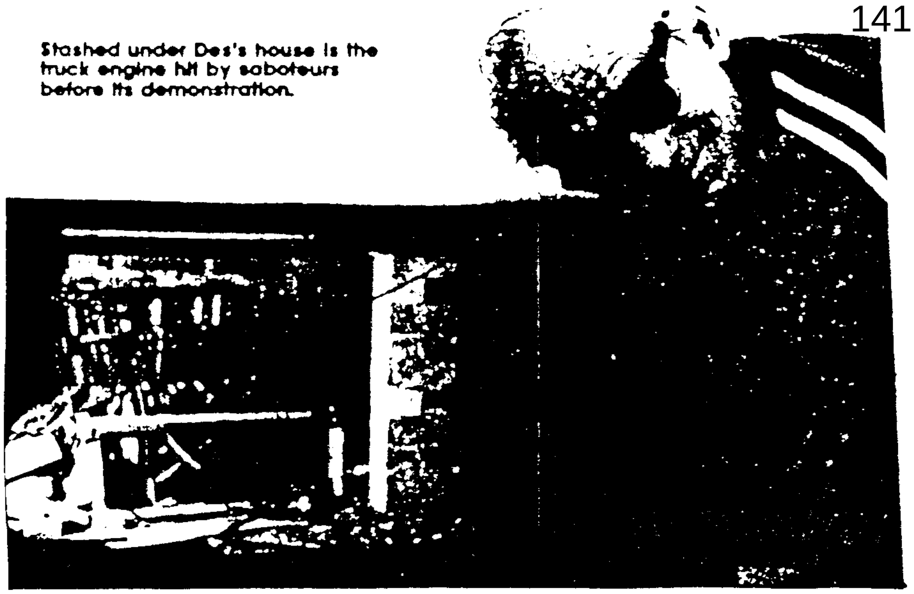
"This whole thing started when I was cleaning some engine parts," he says. "I blew down the tubes to get rid of some carbon dust and I was amazed to see the engine parts working under the force of my lungs It seemed obvious that compressed air was an alternative to fuel.

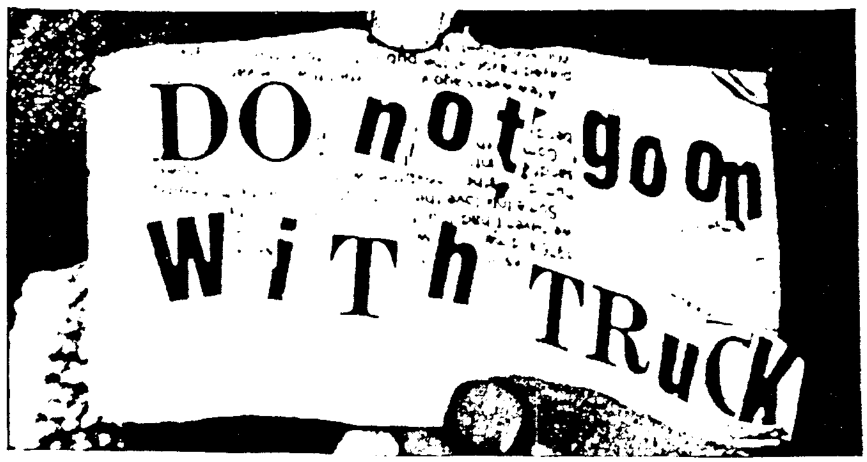
"Even then, I was told by all sorts of different people to give away the idea until the world was ready for it.

"Now I'm sick to death of it I can't work on it without being worried for my wife and family — though I'm not ever scared for myself — so I will have to give it up if I can't get an investor.

"One day someone will find my plans and they'll have enough money to develop my machine and the world will welcome it with open arms

Stashed under Des's house is the truck engine hit by saboteurs before its demonstration.





This crude threat came to Des when he was working on his truck prototype.

"Yep, my mates were right I should have let it be The world wasn't ready for me It's a sad thing when you are ahead of your time "

Anyone interested in helping Des and his machine, please write to The Air Machine, PEOPLE Magazine, 57 Regent Street, Chippendale. NSW 2008.

We will happily pass your letters along to Des who, quite understandably, is reluctant for us to print his address

6-B, Hollywood, Fla., SUN-TATTLER Mon., Dec. 17, 1979

Inventor Hopes Engine Is More Than Hot Air

FORT MYERS (UPI) — Inventor Lee Rogers has a V-8 engine that runs on compressed air instead of gasoline and he hopes to refine his motor to the point where it will free the country from its dependence on oil.

Rogers, former owner of a construction company in Wexford, Pa., says he has successfully converted a 1972, eight-cylinder, 318-cubic inch motor to operate using only a normal 12-volt battery and compressed air.

"It operates on the same principle as the internal combustion engine except it doesn't use gasoline," Rogers said.

"I HAVE AIR going into the cylinders forcing the pistons to fire in the same order as when gasoline is used," Rogers said.

He said he has contacted major automobile manufacturing firms without sparking any interest.

"They said it just won't run, but it's sitting out there in my garage right now running," Rogers said. "No one has ever come down. That's what hassles me."

Rogers also operates the V-8 in his station wagon off compressed air tanks, allowing him limited driving capability. He now is working on a permanent compression which he plans to mount on top of the motor. He says this will enable him to have unlimited driving capability.

THE OPERATION of the air-powered car has been witnessed by a number of persons, including Lee County Sheriff Frank Wanicka, State Rep. Paul Nuckools, and several area reporters.

Nuckools said he had a University of Florida engineering professor down to observe the operation and said the engineer felt the potential of the motor was limited by the amount of energy loss experienced during the operation.

Rogers said he thinks the energy loss would be minimal and predicts once he gets the specially designed compressor completed and installed, his car will be able to do anything a car using gasoline can do.

"IT RAN, WHICH a lot of people didn't think it would," Nuckools said. "He still has to use the old distributor system to time when to allow the air in and it is hand operated, kind of like the old spark lever on the Model T. It obviously needs refining.

"I think he has done a heck of a job," Nuckools said. "It has a tremendous volume of merit."

Nuckools said he thinks the air-powered motor could be a big asset in farming operations, where some type of an auxiliary compressor run by a small gasoline-powered motor could be used to revitalize the motor's compressor every four or five hours to make up for any energy loss.

BUT ROGERS insists that won't be necessary — the refined compressor will handle all the needs.

Rogers said use of air to power the motor does away with the need for a radiator, fan, spark plugs, anti-pollution devices, exhaust systems, fuel pump, water pump, coil, gas tank, gas line, and air conditioning compressor. This, he said, takes several hundred pounds off the weight of the car and reduces the cost.

"I have eliminated close to $3,000 worth of equipment and replaced it with a $9 piece of plastic pipe," Rogers said.

The air coming out of the motor is vented out the rear of the car through a simple two-inch plastic pipe. And it is so cool part of it is recycled into the car eliminating the need for an air conditioner, Rogers said.

ROGERS SAID once the refined compressor is installed, the 12-vote battery will be constantly recharged through the use of the normal generator and regulator on the car.

He said the key to his process has been the use of electrical solenoid valves already in production by Airco in Venice, Calif., which take the place of spark plugs.

"The only working parts that can go bad are the valves and they are guaranteed by the company for 23 million working hours," Rogers said. "That is about 30 years."

ROGERS SAID the motor still needs the normal oil supply to keep it lubricated, but claimed because there is no burning inside the cylinders, the oil last more than twice as along, and said the same is true of the rings and valves in the motor.

He estimated the cost to convert a car to his system once it is refined would be no more than $1,000 and probably as low as $400 to $600.

"This could turn this country around," Rogers said.

ON Magazine THE LEE ROGERS AIR CAR

By Ann Dryden-Stewart

Lee Rogers made a discovery that could revolutioize transportation and liberate the United States from dependency on foreign oil. His invention converts gas-guzzling automobiles into cars that run solely on air.

* * *

Everyone would love to get a very close look at his wonder-car. But not everyone shares his cause. That is the main reaseon why he remains vigilant and unyielding in his standards for marketing his product. Lee Rogers wants the American public to have free access to his invention.

* * *

Rogers described the modified car's variations as percieved by a driver: "The difference in driving an air car and a conventional one can be compared to the difference of changing from an automatic to a manual transmission. The driver has new sensations to deal with, but basically thats all. One adjustment is in the acceleration. In order to gain speed in a gas-powered car, you usually have to press the gas pedal half way to the floor. Even then, it takes additional time for the car to respond. With the air car, it

AIR CAR
May Solve Energy Crisis!

Lee Rogers made a discovery that could revolutionize transportation and liberate the United States from dependency on foreign oil. His invention converts gas-guzzling automobiles into cars that run solely on air.

However, the innovation that Rogers originally envisioned as the realization of an American dream has become no less than an incredible nightmare for the inventor and his family. Since his product was patented, Rogers has lost his home, privacy and some faith in his fellow man. He has gained a more closely knit family and cultivated patient self-determination.

A Prisoner

That's not a bad trade-off for the middle-aged contractor who lives in Fort Myers, Florida. He is convinced his stroke of genius should be unquestionably accessible to everyone. It is that staunch belief that has made him a prisoner of his own ingenuity.

Tired of enormous gas bills and his country's hand-tying dependency on foreign oil, Rogers knew there must be a better way to facilitate getting from one place to another. In the summer of 1979, he picked up a junkyard motor for $50 and began modifying it in his garage. The family station wagon served as guinea pig. Protective of his idea, what work Rogers couldn't tool himself, he farmed out in small quantities to machine shops in the area.

"My air car operates on the same principle as the internal combustion engine, with one major difference," Rogers said. That difference will make travel by car, truck or RV much cheaper. But, in addition to not using gasoline, the redesigned works under the hood eliminate the radiator, fan, spark plugs, anti-pollution apparatus, fuel and water pumps, and, best of all, the gas tank. Some conventional parts have remained on Rogers' prototype air car: accelerator, engine, distributor, cluster of hoses and valves. Other equipment which has been added due to the nature of the invention include an air compressor, compressed air tanks, and a plastic pipe that serves as the exhaust system. (No heat is created due to the cold temperature of the compressed air.)

Not being accustomed to this instant burst of power, Rogers found himself driving with his front wheels two feet above the street during a test run.

Rogers described the modified car's variations as perceived by a driver: "The difference in driving an air car and a conventional one can be compared to the difference of changing from an automatic to manual transmission. The driver has new sensations to deal with, but basically that's all. One adjustment is in the acceleration. In order to gain speed in a gas-powered car, you usually have to put your foot down on the gas pedal halfway to the floorboard. Even then, it takes additional time for the car to respond. With the air car, it only takes a foot movement of a quarter inch. The acceleration rate is instantaneous."

Will Lee Rogers be hailed a national hero or will his genius be buried by the oil cartel?

Not being accustomed to this instant burst of power, Rogers found himself driving with his front wheels two feet above the street during a test run.

Free Enterprise?

Why hasn't this motoring miracle hit the market? Why isn't Lee Rogers a multi-millionaire basking in the warm glow of success, instead of practically being a prisoner behind invisible bars? Lee Rogers has discovered through a very painful process that the free enterprise system is sometimes not

by ANN DRYDEN-STEWART

as free as most Americans would like to believe.

A cartel of automakers offered Rogers millions of dollars to buy his patented air-power conversion kit. Rogers refused, fearing his idea would never be heard of again, much less incorporated into auto assembly lines.

Countless numbers of people have contacted Rogers with offers and promises, except the offers have miles of strings attached and the promises disappear as mysteriously as they materialized.

"Some of these folks come in and say they are such and such, representing a certain company, and we discover later the person or the company never existed. While one man was visiting, I wrote down his license plate numbers—he was from out of state—and when they were checked out, even *they* were phony," commented a baffled Rogers.

Everyone would love to get a very close look at his wonder-car. But not everyone shares his cause. That is the main reason why he remains vigilant and unyielding in his standards for marketing his product. Lee Rogers wants the American public to have free access to his invention.

Unfortunate Greed

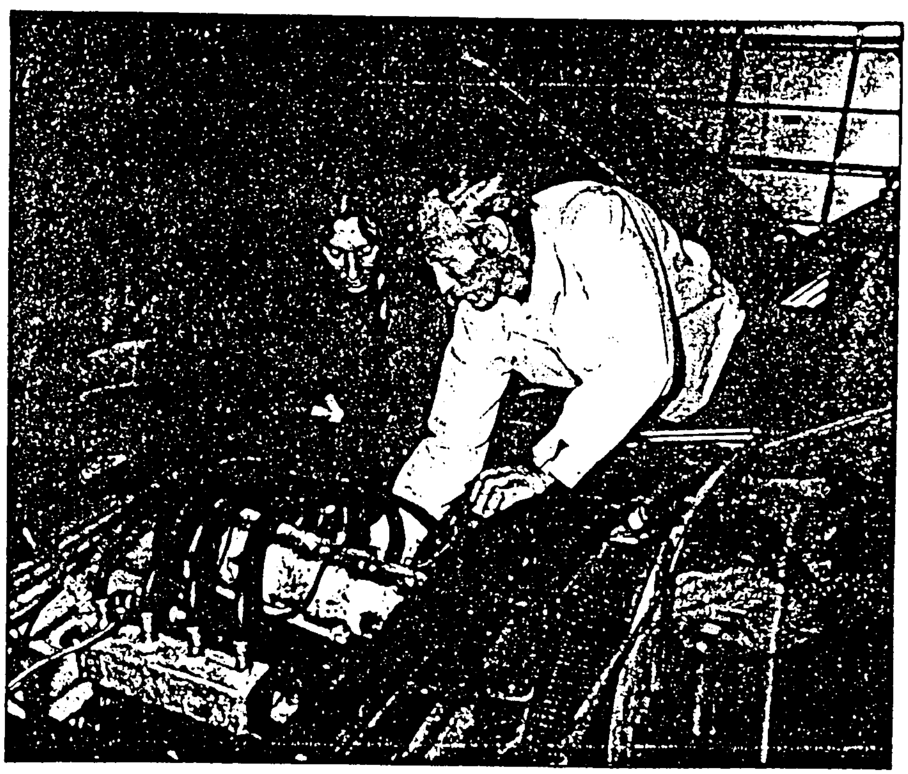
"It all boils down to greed," Rogers said, "especially on the part of those who already have so much. Unfortunately, my family has suffered because I would not yield to the dollar."

Strange cars with unidentified passengers have parked outside their home.

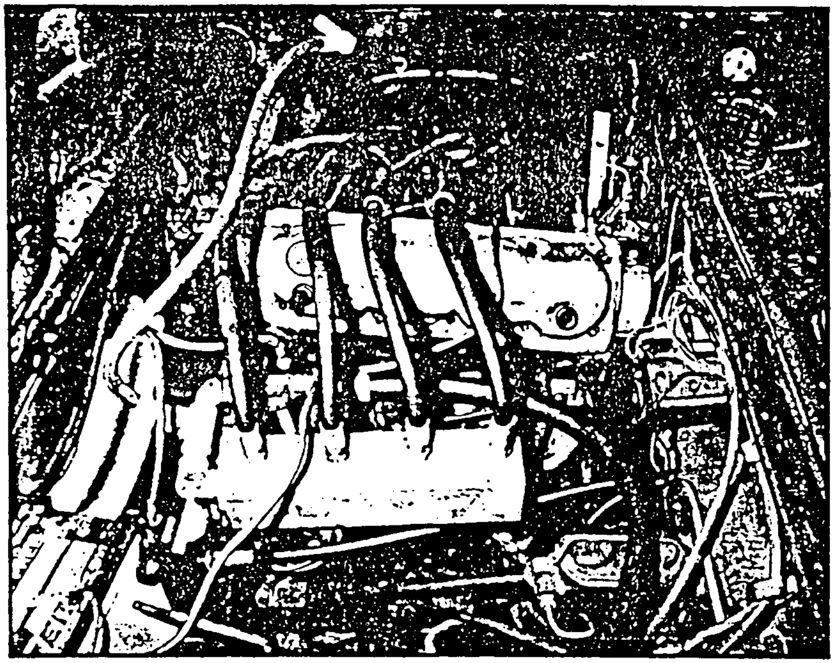
Rogers has invested everything he had saved. His family has sold off every incidental item in the household to keep themselves free of financial manipulation. Still there are those who have attempted to find other ways to grab Rogers' invention. Take, for example, the man from whom Rogers was buying his home. Rogers claims the man wanted a part of the air car as an investment. Rogers refused. Consequently, the Rogers family was routed from their home after a disappointing legal battle.

Under Surveillance

Blended in the stream of curiosity-seekers who have contacted the Rogers are those with questionable ulterior motives. Strange cars with unidentified passengers have parked outside their home. Clandestine meetings



Lee Rogers and associate make minor adjustments to the air car prior to taking a test run.



Rogers' design eliminates the radiator, fan, spark plugs, anti-pollution divices, and fuel and water pumps.

in out-of-the-way places have been proposed to Rogers by parties who refuse to give their names. He has now discovered that his phone is tapped, with calls monitored daily.

"Is it all worth it?"

"Sometimes when I'm awake at 3:45 a.m. and see my kids sleeping, (Rogers has two sons and one daughter living at home; his oldest girl is married) I wonder if it is all worth the trouble we've been through. I wonder where the next hundred or thousand dollars will come from to keep my family going. I wonder if I shouldn't have taken some of those first offers and been done with it. My wife Betty Jean has put up with all of it. Right now it seems that every time we start to build up, someone tries to knock it all down," confided Rogers.

He has now discovered that his phone is tapped, with calls monitored daily.

Rogers, however, knows that despite his contact with those of questionable character, there are many people who have every good intention in the world for him, his family and his invention. There is the lady in Naples, Florida, who opened a savings account in Rogers' name and publicly asked other citizens to donate a dollar to keep his project going, and the man who sent him a check for $500 to use as he pleased. Hundreds of well-wishers have sent letters of praise and encouragement. They have offered prayers for his continued success. Those actions have spoken the best to Lee Rogers and his family. They have offered hope during times of defeat and discouragement.

Only a Matter of Time

"I'm at a standstill right now because of my finances, but all we need now is money to set up the manufacturing plant for the conversion kits. When the kits go on the market for the acceptable price of around $1,000, everything will be fine. It's only a matter of time," reassured Rogers. "Experts have studied it, and they know it works. It's only a matter of time. . . ."

For the sake of the country and the spirit of Yankee ingenuity, there is hope that day will come soon. But for the sake of Lee Rogers and his supportive family, that day should arrive with haste: Lee Rogers should never have to awaken from his American dream.

Compressed Air Powers This Conventional Auto

By Mark Newhall, Managing Editor

We've heard stories for the past couple years about an inventor in Florida who has figured out a way to run conventional internal combustion engines on compressed air.

Now, thanks in part to a report by a free-lance writer in "On Magazine", we've received further details and photos of the air-powered car invented and patented by Leroy K. "Lee" Rogers, a Ft. Meyers, Fla., building contractor. Rogers, who was inundated after early reports on his invention by crowds of reporters, manufacturers, potential investors and the just plain curious, has apparently gone "underground".

Rogers began work on the air car in his garage in 1979, trying to find a reliable way to feed compressed air to conventional gas engine pistons. His first car was an 8-cyl. 318 cu. in. 1977 Dodge Aspen wagon.

Rogers stripped the car of its radiator, fuel pump, carburetor, spark plugs, and exhaust system. He replaced the engine's carburetor with a "distribution block", a rectangular hollowed-out aluminum box that channels compressed air to each of the eight cylinders. Special valves replaced the spark plugs, and the hole where the fuel pump had been attached to the engine was plugged. All emission control devices were scrapped and the entire exhaust system was replaced with inexpensive plastic PVC pipe.

Glynn Wiggins, Hendersonville, Tenn., is an instructor of auto mechanics who recently received his doctorate in auto mechanics education at the University of Tennessee. He's seen the converted car and helped Rogers iron out some of the bugs in the system.

"The engine makes almost no noise. Exhaust air is actually cooled as it's exhausted because of the sudden drop in pressure, which is how refrigeration systems work. The day I was there the outside temperature was 80 to 85° while the engine exhaust temp. was 40 to 50°," Wiggins told FARM SHOW. "The engine is also very powerful. I can kill the engine in my own 400 cu. in. Pontiac by putting my hand over the exhaust pipe but I couldn't even hold my hand over the exhaust on the air-powered engine. When the car went for its first test drive, it accelerated so fast it lifted the front wheels of the car off the ground."

Here's how Lee Rogers described the experience of driving his air car to "On Magazine": "The difference in driving an air car and a conventional one can be compared with the difference in changing from an automatic to manual transmission. The driver has new sensations to deal with, but basically that's all. One adjustment is in the acceleration. In order to gain speed in a gas-powered car, you have to put the gas pedal halfway to the floor. With the air car, it only takes a foot movement of a quarter inch. The acceleration rate is instantaneous."

The engine works on just 80 lbs. of air pressure. Rogers removed the gas tank and replaced it with three small tanks about the size of pressurized-carbonated beverage containers that'll hold 2 to 3 cu. ft. of air. A key feature of the air system is that it takes in a tremendous amount of outside air — about a 20 to 1 ratio to the pressurized air — and recaptures the pressurized exhaust air in the air storage tanks. In other words, Rogers says the car pressurizes enough air on the go to help power itself and require less refilling.

"The system has to recapture 1/20th of the air passing through the engine. One of the problems left in developing a marketable kit that'll install on any engine is that the blower used to recapture pressurized air off the engine is too efficient. It needs to be down-sized to capture only as much air as is needed," Wiggins explains.

Rogers starts the engine with the car's electric starter and then opens the throttle, or air supply lines. "After 3 to 5 min. of operation, the exhaust is actually cool to the touch. The engine is simple, powerful, quiet running and has low maintenance requirements. I detected no contradictions to the inventor's claims. It went far beyond my expectations," Wiggins told FARM SHOW.

The air-powered engine conversion kit reportedly will work on any gas-powered engine. Rogers has already installed his second conversion kit in a 4-cyl. Chevrolet Vega engine. The idea may also work in diesel engines but, since they operate at higher pressures and don't have spark plugs, a different approach would have to be taken.

Wiggins says the biggest roadblock to getting the Roger's conversion kit — which has been designed to cost \$1,000 to \$1,500 — into production has been a lack of funds to finish testing.

"He has had many offers of money but everyone wants to buy the invention outright. He figures it would never get on the market if he did that, so he has continued to finance all research and development on his own. There's no doubt the technology is there but it will take time to put everything together," says Wiggins.

This article courtesy

INVENTOR REFUSES BILLION DOLLAR OFFER!!

AUTO RUNS ON AIR!

By Gilbert Lawrence

Consumers Guide —April 15, 1980

"...Actually, they offered me over a billion dollars — but I was afraid the big three would just buy it up and never have any intentions of releasing it to the consumer!" — Lee Rogers, Inventor

The following feature, to many American Consumers, may seem difficult to believe. --- It none the less is true! This is not just a story of one man's desire to overcome the suppression of massive odds against himself, but, entwined within his destiny and within his hands he may hold the future destiny of America and the free world. You may never need ask again, "Whatever happened to good old American ingenuity?...Where are the modern day Graham Bells, the Wright Brothers, Henry Fords and the likes?"

No doubt, we have all heard the expression "Don't look a gift horse in the mouth," but, who among us could look a billion dollar plus offer in the face and say - NO! Well, it may sound like a good plot for a television series (we all remember "The Millionaire"), but it's no fiction, it happens to be the truth. "The Big Three," apparently pooled their automotive fortunes and efforts to the tune of over one billion dollars! All they wanted in return were the absolute patent rights owned and already registered to Lee Rogers, for an automobile that literally runs on air.

Rogers, a forty-one year old residential contractor, from Iona, Florida had one underlying fear. He had a near obsessive concern that the automotive industry might merely 'shelve' his revolutionary invention and keep it off the market. Rogers might well be right, if all indications prove correct! His idea to operate any regular gas designed engine on compressed air could cut America's massive dependence upon foreign oil. Because, as Lee Rogers says, "It's probably the closest thing to a perpetual motion machine that may ever be invented."

* * *

News of Lee Rogers revolutionary design, reached Consumers Guide Editors and immediately we went to work to separate fact from rumor. As I quickly found out, this wasn't an easy task. For some reason, there almost seemed to be a "Media Black-Out," when it came to acquiring information on this potential block-busting invention.

* * *

How could it be, I asked myself; if in fact, as Lee Rogers had stated, his invention was probably the closest thing ever to a perpetual motion machine, that no one, including AP, UPI, NBC, CBS, and ABC had not grabbed up this little gem and really ran the distance.

For whatever their fears or reservations the balance of the media seemingly held back, and given the

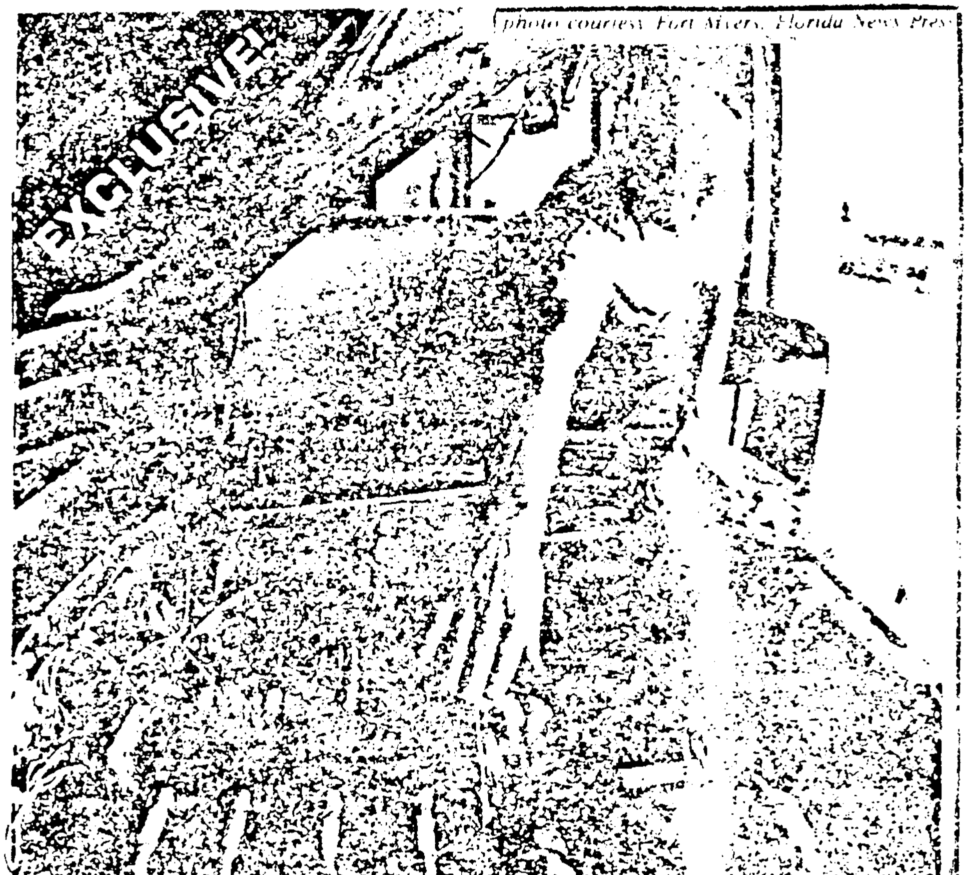


photo courtesy Fort Myers, Florida News Press

LEE ROGERS OF IONA EXPLAINS HOW AIR POWERS HIS CAR
...no other fuel is used to run the vehicle.

initiative of time, the Guide continued to forge ahead to expose the inventive genius — or fraud of Lee Rogers.

As the days grew into several weeks, bit by bit, piece by piece, the Rogers story started coming together. Many unanswered questions and doubts were investigated...and the solutions to the skeptics questions were answered with hard facts.

* * *

Example: why did Dr. Larry Bagnall, noted University of Florida

agricultural engineer, criticize Rogers' invention, saying, "Rogers might just as well use a horse to turn a windmill!" Further, Bagnall stated: "I would roughly estimate that it would take twice as much energy to fill the tanks and compress the air as the engine could ever produce. After all," Bagnall continued, "Rogers will have to use more fuel to compress the tanks of air than the auto normally would use!" Rogers, not one to be at a loss for words, countered Bagnall's attack with a chuckle, "the compressor will be continually fueled simply by the power from the engine itself."

As Rogers later stated in an exclusive Consumers Guide interview, "I work on one problem at a time. First, they told me it was impossible to run an auto engine on just plain 'pure' simple air and I said, Why? After all," as Lee Rogers continued, "All gasoline does is create a 'hot' explosion driving the pistons up and down, and the only reason it's a hot explosion is because it's ignited. So, I got to thinking, no reason why the air has to be hot! Why not just regular cool everyday air like you and I breathe?"

"Sounds good," everyone would say, "but it'll never work!" "Well, I made it work! I proved it! I not only started it, and idled it (for many, many hours), but I took 'em for a drive in it. — Now let 'em tell me it can't work!"

* * *

State Rep. Paul Nuckolls, (R) Fort Myers, who just happens to be on the House Agricultural Committee, sees the Rogers invention as a potential revolutionary breakthrough for the farming industry. Without the high cost of fuel, that the farmers are presently faced with, food prices could be slashed.

* * *

Rep. Nuckolls personal aid, Jim Siford, stated to The Guide, "I remember the day we all went down to Lee's for a look. A whole group of us were there. We had heard all types of rumors, and Mr. Rogers walked out to his garage with us explaining, 'it just simply runs on air.' One gent who was there with us, who I dare not name, said, 'if that thing even starts, I'll consider it a miracle!'

"Well, Mr. Rogers opens up the garage door and there sits a regular looking 1977 Dodge stationwagon. After showing us the modifications, Mr. Rogers hops in and not only starts her up, he backs down his driveway and waves to us, as he drives off down the street. You could have knocked us all over with a feather!" Siford concluded.

* * *

(EDITOR'S NOTE: Accompanying this article is the Guide exclusive interview with Lee Rogers.)

Consumers Guide interview with inventor Lee Rogers:

Air-powered auto is a reality!

By JERRY KEEFE

LEE ROGERS is a resident of Iona, Florida, a small residential area outside Ft. Myers. He believes he's invented a car that runs on compressed air; no fuel, no combustion, just the power of air trying to free itself from the cylinders of a V-8 engine.

Rogers' idea to run an automobile on compressed air was sparked by the energy crunch two years ago. This idea has been fueled by his technical progress on the engine, and his desire to change the nature of the auto industry, thus freeing the consumer of spiraling gasoline costs and cut America's umbilical cord with the energy-rich Arab nations.

Lee began by tinkering with his 1977 Dodge Aspen station wagon. He removed all the gasoline components from his car's engine, including the carburetor, spark plugs, gas tank, fuel pump and exhaust system.

The old Dodge was originally fueled by pressurized air tanks that Rogers had purchased. He has since designed an air compressor that provides a continuous supply of air to the engine. A conversion kit, that he developed, attaches to the engine block, pumping pressurized air into the cylinders — and it works!

* * *

"Simply, it just runs on air instead of gas," the 41-year old former home builder says of his first invention. "Instead of gas, it just has air going in to drive the pistons up and down. It's so damn simple nobody believes it."

* * *

That includes Jimmy Carter, the Department of Energy, Ralph Nader and the major U.S. car manufacturers, all of whom Rogers has contacted with little or no response.

Rogers contacted the major auto companies last year and tried to interest them in his idea. But, they apparently wrote him off as a nut and ignored his request to come and see his perpetual motion machine.

* * *

Apparently the Big Three believe him now. After a great deal of publicity and documented facts, they have pooled their bargaining efforts and offered him "over a billion dollars" for his patent.

* * *

"Chrysler and General Motors asked me to send it to them, but they didn't believe I could turn it (the engine) over." Rogers says with amusement. "Hell, I can let it idle eight hours a day or more, take it on a test run and reach speeds up to 80-miles per hour. And when you look at the engine, it has a nice frosty cool appearance to it and is cold to the touch."

"There's a couple little tricks to my invention that I haven't told nobody. My wife doesn't even know about em'. Like I told Chrysler, if you had this idea you could be No. 1 instead of being on the brink of bankruptcy. They said, 'Well, send it to us. We don't expect it to run.' But they want me to practically sign the patent over to them."

And Rogers has his engine patented to the hilt. He has about $7,000 of his own money in his own invention so far, he says.

Mr. Rogers fears that if the big auto companies did buy his creation, they might hold back the production of a car that runs for years with no internal combustion or tune-ups.

"And if they did make this car, where is the average consumer going to get the $16,000 or $20,000 to buy one?" Rogers asks.

Lee Rogers plans to build a "converter kit," that will adapt to any American built auto, mass produce them, and sell them outright. He feels that if he builds and sells them on his own he can protect his patent, help out the consumer, save his country from the [illegible] squeeze and make a considerable sum of money to live on.

* * *

He touts his invention as one solution to smog and the energy crisis, and says that when it is completed, it will run as fast as gasoline-powered engines and revolutionize the industry.

"Ford Motors told me the engine would never run on air. They said it's designed to run on combustion only, created by a fuel," Rogers adds, "nobody believed it would work because they said if it would work they would have done it a long time ago!"

In the process of designing and building his perpetual-motion machine, Lee Rogers had to have every part made at various machine shops. Many times the various parts had to be modified, redesigned, or completely remade.

"My invention would turn inflation clear around. If enough American people know about it — they're going to push for it. The auto companies could have created this ten years ago. Frank Kelly, my neighbor, who has assisted me in the assembly of the engine, and I can't change the country by ourselves. We need help from everyone to put pressure on the auto industry to give my engine a chance."

Rogers', '77 Dodge is currently running at 96% H.P. efficiency, compared to only 26% for gas powered vehicles.

Lee Rogers' air-powered conversion kit (when manufactured) could be adapted to any American made auto and would [illegible] could be [illegible] mechanic at a nearby gas station. The car keeps a battery to power the lights, accessories and to start up the air compressor.

Now, assuming you have bought the conversion kit, had it installed, you are now ready for your initial test run. But, first you must spend $14 for a tank of nitrogen to charge all four air tanks that are mounted where the gas tank used to be. You have the main tank, and the other three are reserves. The compressor is fueled simply by power from the engine and as the engine runs, it's constantly rebuilding its own air supply. As one tank empties, another is being filled...and so on. When the charge gets up to 500 P.S.I., the auto is ready for the highway. The nitrogen is a one time purchase. It also cleans, blows out all oil and gas residue, cleaning the valves, the engine and everything else right out to the exhaust.

Now, step into the car, turn on the key — give it some air (step on the former gas pedal) and away you go.

The whole concept of the perpetual-motion machine is based loosely on the same theory of an air-gun. The former gas pedal acts like a trigger and gives you various speeds when you press down on it.

CURRENT PROBLEM

What stands between Lee Rogers marketing the converter kits now or at some time in the near future, is a slight problem he hopes to soon solve. At low speeds, the auto uses the air pressure up in about 20 minutes.

"The engine doesn't run fast enough at 5 to 15 mph to rebuild the air supply. The air pressure has to reach about 2,000 RPM's to remake its own supply." Lee chuckles and adds, "But it's merely a matter of gearing and some slight changes. I'm very close to solving the problem. Very close," he adds and grins.

And grin he should. Lee is on the verge of creating complete havoc in the automotive world that for years has been dependent on the oil and gas companies. And should his design work, the hiss of his air exhausts sweeping across the nation will be topped only by the screaming and yelling of the money hungry oil and gas magnates pulling their hair out.

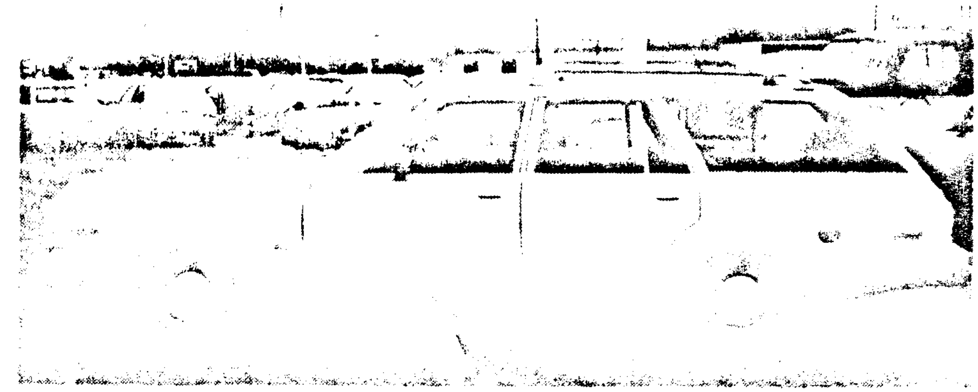
* * *

MODERN DAY HERO

In this day and age when heroes are a rarity, Lee Rogers is certainly destined to be a cult hero. The 41-year old building contractor is gaining a cult following with engineers, mechanics and farmers who call day and night and even stop by his house, the location of which Rogers is trying to keep 'Top Secret.'

The usually calm, soft-spoken man sometimes breaks into a hearty laugh when he recalls what some people have gone through to beg a glimpse of the air-powered engine or just to shake the inventor's hand. A farmer flew in from Wisconsin and wanted to buy 18 conversion kits for his tractors; when he arrived he still had on his bib overalls.

An older couple named Rogers — **drove down from North Carolina, simply to congratulate another Rogers. And on and on it goes...phone calls, visitors, TV, radio and newspaper reporters...all hoping to catch a glimpse of the Dodge running on air. All the attention has built up to the point where**



LEE ROGERS has adapted his 1977 Dodge stationwagon (similar to photo shown here) with an airpowered engine that has the auto industry worried.

photo/BILL LANGHORST

Rogers is finding a little privacy hard to come by.

He has an unlisted phone humber, and for some, the journey to see the perpetual-motion machine ends indisappointment. Lee Rogers attorney has insisted that all viewing by unknowns be halted and that his "secret" be guarded and kept under lock and key.

Years from now, we may be breathing clean air as we sit on our porch in a rocking chair...telling our grandchildren about the legend of Lee Rogers and how he slew the giants of the auto industry with his creation of a perpetual-motion machine that revolutionized the auto industry and just possibly saved mankind from walking the face of the earth with a gas mask and a tank of oxygen strapped to his back to breathe with.

*

Note: In our conversation with Mr. Rogers he has expressed a concern for the preservation of his privacy, in order that he may maintain some semblance of normal life. Thus, in accordance with Mr. Rogers wishes, Consumers Guide will not publish any direct contact information. Should you desire to correspond with Mr. Rogers, please write to:

~~***Lee Rogers***~~
~~***c/o Consumers Guide***~~
~~***P.O. Box 2700***~~
~~***Toledo, Ohio 43606***~~

~~***The Guide will forward all correspondence to Mr. Rogers.***~~

Auto runs on air update: Consumers Guide 1980

Inventor ponders coast-to-coast trip with Air/Auto

By GILBERT LAWRENCE

Lee Rogers is quickly learning that the way of an inventor is saturated with temptations, ridicule and extreme financial hardships.

Mr. Rogers is the inventor of an air powered automobile. On April 15 the Consumers Guide published an exclusive article about this innovative hard-working 41 year old former home builder.

Since then, this writer in the company of Duane Pheils, made a 2,600 mile round trip to obtain an interview with Lee Rogers and his wife Betty Jean, at their home located in Iona, Florida.

Two extremely dour eyed Dobermans saw us through the door and inside, we found the slender affable Mr. Rogers and the (at first) somewhat reticent Mrs. Rogers awaiting our arrival.

As we conversed, their strange — but inspiring — story unfolded. "Two years ago," Mr. Rogers told us, "we, the family, went on a vacation in our motor home. The cost of fuel was astronomical and I said in jest 'When I get back home, I'm going to invent a car that runs on air!' Of course we had a good laugh over such a ridiculous idea."

Mr. Rogers paused a minute to wipe clean his spectacles before continuing, "But, somehow, the idea wouldn't leave me. Maybe it became almost an obsession. Anyhow, within a few days I was thinking deeper on the subject and even drawing rough sketches and mentally probing the theory."

Prior to the idea of the air-car Mr. Rogers had been a successful home building contractor where he earned a

LEE ROGERS

high medium income. It was quite evident that he was more than a little successful in this pursuit. He could not conceal his pride when he recalled, "One time I had to complete a home for a doctor in 90 days. Problems plagued me from the beginning. My son and I did the job practically, and managed to complete it within the 90 days allotted. The doctor was pleased and I really felt deep satisfaction."

The foregoing is illustrative, I think, of the kind of a man Lee Rogers is. He is stubborn, industrious, hard working and, although, he can claim no degrees in higher learning; he is driven by good common sense and dedication to seeing things through to a successful conclusion.

He is in good company here I mentioned, as I was unable to recall the **degrees boasted by Henry Ford, the Wright Bros., Thomas Edison, and** countless others. There was no comment from Mr. Rogers, though.

Later, seated around their dining room table we learned many things we hadn't realized before, namely, the sacrifices that this famiy has made to create an air powered engine that surely will revolutionize industry and the life style of the entire world.

Gone is the motor home of which they had spoken so fondly as are the dune buggies they once enjoyed. As a matter of fact one came away with the realization that the entire family's energy and direction has gone into the evolution of this concept. As a result, many of the niceties we take for granted have been forsaken by them

The entire life style of this tightly knit supportive family has thus been altered by the money devouring dream of the head of the household.

While it is amazing enough that they have not complained, it is almost unbelievable when it is realized that they have turned down over a billion dollars, more than once, for the invention, as Mr. Rogers claims.

Before I ask why, Mr. Rogers exlaimed, "But that is O.K. with all of us because we not only want to do something for ourselves, but we want to do it for everybody in this nation!"

And he means it. So does Betty Jean. Frequently, throughout our long exclusive interview, both of them spoke of the outrageous oil prices which, "Border on pure blackmail!"

They are painfully aware of the dying American economy, the balance of trade deficits, and the general turmoil which they b[illegible]ieve are all manifestations of [illegible] oil dependent economy.

"This country just can't continue to pay the always escalating costs of energy," Mr. Rogers explained, "We just don't have it!"

And this is why Mr. Rogers and his family have refused all offers to date for the rights to this revolutionary engine. They are convinced that if they do sell it, it will end right there; that selfish interests will "shelve" the invention to maintain the status-quo. "That wasn't our dream and it still isn't," Mr. Rogers said flatly.

There is help expected in the near future, however. It will be in the form of a grant from the State of Florida. This grant does incidently, have the personal support of the Governor of the state, Reubin Asken.

One of Mr. Rogers' personal attornies is Representative Paul Knuckels, who is also Chairman of the House Agricultural Committee of the Florida State Legislature.

Evidently, these two highly placed officials of the state are convinced that Lee Rogers, indeed, has developed a feasible engine which will operate at more than 95% efficiency and is just a hair's breadth away from true perpetual motion.

The proposed Florida grant is to allow Mr. Rogers the funds to refine the engine so that it will propel any size automobile, and be adaptable for use on older automobiles. The idea is to have the final product available in "kit" form.

"Right now," declared Mr. Rogers, "farmers could be plowing their fields in air powered tractors!" In fac[illegible] according to Mr. Rogers, "They w[illegible]

already be doing just that if I was not so cautious in having everything, perfect with respect to design and legal ramifications."

According to Mr. Rogers the farmer will first have the engine made available to them before anyone else. "My God!" he exclaimed, "do you realize what the cost of fuel is doing to the farmer? It is getting so bad that they can barely afford to grow the American's food!"

Mr. Rogers is perfectly aware of the shock to the world's economy if great care is not exercised in gradually

"feeding it" into industry of all kinds.

Soon, [illegible] trip to California and back in an air powered automobile. This, he feels, will convince all skeptics, as to the viability of his design. In addition he hopes to call the American people's attention to the fact that there is, after all, "A promise in the future for them."

EXCLUSIVE!

Ford purchase of air-car design alledged by Rogers

By Jerry Keefe

In an exclusive Consumers Guide interview, in Iona, Florida, inventor Lee Rogers alledged that Henry Ford II purchased patent rights to a previously designed "air/engine" and information was on *record in* Washington, D.C.

* * *

Mr. Rogers told the Guide that his wife had received a phone call from a former 'Big Three' executive, who was now retired. The unidentified caller felt obliged to warn Lee Rogers not to sell his air/car design to any of the automotive manufactures because he felt that they would never develop it and the idea would just get shelved. The mysterious caller went on to say, "I know, because Ford has already done just that!"

* * *

Lee Rogers, is the inventor of an auto engine that literally runs on air. The exclusive article appeared in the April 15 issue of the *Consumers Guide* and set off a storm of controversy from coast to coast. The phone call was indeed a blow to Mr. Rogers, who up until this moment assumed he had an exclusive patent on a revolutionary theory.

* * *

Lee Rogers alleged that the former executive was ready to back up his phone call with absolute proof. Knowing that Mr. Rogers would doubt his story, the caller went on to tell him the location and number of the 'Air/Engine' patent that Henry Ford II had purchased several years previously.

Rogers, obviously puzzled, asked aloud "why in the world would Henry Ford II purchase the patent rights from an inventor and then just sit on it?"

Mr. Rogers claims he quickly boarded a flight to Washington D.C. and that at the U.S. Patent Office, much to his dismay, there was in fact registered under the patent numbers given him by the retired auto executive, the previously described patent.

Inventor Rogers was quick to point out several differences between his air car design and that of the Ford ownership. The patented design purchased by Ford was for a 6-cylinder engine, using the two forward cylinders for the thrust for air. Whereas, the Rogers design (also patented) is adaptable for eight, six or four cylinder use and as Mr. Rogers stated, "several major differences exist between my *patent and* that of Ford."

Oddley enough, of the Big 3, Ford Motor Company was the only auto maker that showed no concern when first hearing of the Lee Rogers revolutionary air/car design.

* * *

Presently, the Consumers Guide is working with the office of nationally syndicated columnist Jack Anderson, in a combined effort to determine the exact facts.

If indeed, the Rogers allegations are collaborated and the U.S. Patent Office records prove a registered patent for an air/engine design was purchased in excess of one million dollars by Henry Ford II, many questions regarding the air/engine will need to be answered.

* * *

Ford's answer:

The Guide contacted the Ford Motor

Continued on page 8

And with a 30-year warranty--

A car that runs on air? That's incredible!

BY TOM HOLLATZ

There's a television show called "That's Incredible". So is the following story.

Imagine getting 23 million miles to a tank of fuel that reportedly costs no more than the cost of putting air in the tires of your car.

Incredible, right? Very few people believe it, but the father-in-law of a Minocqua motel owner has seen the car and reportedly driven in it in Fort Myers Beach, Fla. Clarence Roessler, the inlaw of Don Nelson of Motel Minocqua, has seen an automobile engine that is powered by compressed air which has been patented by an inventor. Reportedly, the developer has been contacted by major automobile corporation officials, who thus far have expressed unanimous disbelief in the idea, according to a story in the Fort Myers Beach Bulletin newspaper.

Lee Rogers, 41, designed the engine in his head two years ago after being frustrated with $7,000 yearly gasoline bills generated by his Pennsylvania building firm. After moving to Florida, Rogers went to work on his engine when he couldn't find work.

Rogers converted a 318-cubic inch Chrysler engine in a 1977 Dodge Aspen station wagon. The motor is driven by compressed air, forcing the pistons up and down in the same manner as gasoline drives an internal combustion engine.

According to the story in the Bulletin, once the engine is primed with compressed air it runs in a self-sustaining cycle.

According to the Nelsons, "60 Minutes", the popular CBS television show has filmed Rogers and his engine.

The idea is basically simple. The engine has been converted to house eight air hoses going into each of the eight cylinders from a distribution block which sits atop the engine block. The compressor sits forward of the distribution block and controls the volume of air being forced into the engine, which in turn controls the speed of the vehicle, according to the newspaper report.

The driver observes the pressure in the air tanks with the help of two gauges on the dashboard. The pressure of the air being forced through the engine also is watched.

Here's the fun part! Rogers removed the gas tank, carburetor, fuel pump, spark plugs, points, condenser and the entire exhaust system from his car to accommodate his conversion unit. Just think, no gasoline fumes and no pollution. Cold air recycling through the engine can be used to air condition the car.

Rogers said he can guarantee the engine for 23 million hours, or 30 years.

Maintenance? The only requirement is frequent oil changes, tire maintenance and regular brake checks. He also claims that rings and valves could last two to three times longer because there is nothing to foul them.

"This could turn our country around," Rogers said in the Bulletin's story. Farmers could convert tractors as could truck drivers. Even snowmobiles and outboard motors could be converted. The list is endless. How about a generator to make your own electricity and heat, for pennies?

Rogers' wife, Betty, admitted that she did not believe her husband until she and a neighbor rode in the car.

"We didn't realize how important this is until we came back and sat down and realized we had ridden in a car that wasn't using gas," she said. The toughest part of their discovery, she added, has been convincing people that it really works.

Rogers has patented both the engine in the station wagon and another whole engine and transmission to protect himself.

Rogers, the story went on, claimed that production of the conversion kits could produce about 3,000 units a day and be available to the public at $800 to $1,000 apiece.

Rogers said if he doesn't get support, he will market the idea himself. Nelson said that Rogers wants to help the working man in his constant fight against soaring oil prices and the stranglehold that OPEC has on the U.S. "I hope he doesn't sell out to some car firm which just might put the idea on a back shelf? I don't think he will," Nelson added.

Since the early days of the oil squeeze, people have been saying "There has to be another Edison somewhere in the U.S." If Rogers' air compressor-engine is all that the newspaper story and Nelson say it is, Rogers could be that "Edison."

The Lakeland Times -- May 1, 1980

How about car that runs on nothing but air?

By JOHN HUBBARD
Times Business Editor

Move over, Times reader Cliff Greenman.

Make way for another Belmont observer of things revolutionary on the automotive scene — Martin Torgerson, owner of Village Cleaners.

Remember, earlier this year, Cliff, when you told us how excited you were over a new process developed by a Southern California company for producing vehicular fuel from sunlight and water?

Well now, what would you say about a car that reportedly runs on nothing but air.

That's what Torgerson has stumbled onto, by reading the Lakeland Times, a weekly newspaper from his former Wisconsin hometown of Minocqua which he subscribes to by mail.

In a recent issue, the Minocqua paper — quoting liberally from still another newspaper in Florida — ran an article on this invention.

Here's the meat of it:

"Imagine getting 23 million miles to a tank of fuel that reportedly costs no more than the cost of putting air in the tires of your car.

"Incredible, right? Very few people believe it, but the father-in-law of a Minocqua motel owner has seen the car and reportedly driven in it at Fort Myers Beach, Fla. Clarence Roessler, the in-law of Don Nelson of Motel Minocqua, has seen an automobile engine that is powered by compressed air which has been patented by an inventor. Reportedly, the developer has been contacted by major automobile corporation officials, who thus far have expressed unanimous disbelief in the idea, according to a story in the Fort Myers Beach Bulletin newspaper.

"Lee Rogers, 41, designed the engine in his head two years ago after being frustrated with $7,000 yearly gasoline bills generated by his Pennsylvania building firm. After moving to Florida, Rogers went to work on his engine when he couldn't find work.

"Rogers converted a 318-cubic-inch Chrysler engine in a 1977 Dodge Aspen station wagon. The motor is driven by compressed air, forcing the pistons up and down in the same manner as gasoline drives an internal combustion engine.

"According to the story in the Bulletin, once the engine is primed with compressed air it runs in a self-sustaining cycle.

"According to the Nelsons, '60 Minutes,' the popular CBS television show, has filmed Rogers and his engine.

"The idea is basically simple. The engine has been converted to house eight air hoses going into each of the eight cylinders from a distribution block which sits atop the engine block. The compressor sits forward of the distribution block and controls the volume of air being forced into the engine; which in turn controls the speed of the vehicle, according to the newspaper report.

"The driver observes the pressure in the air tanks with the help of two gauges on the dashboard. The pressure of the air being forced through the engine also is watched.

"Here's the fun part! Rogers removed the gas tank, carburetor, fuel pump, spark plugs, points, condenser and the entire exhaust system from his car to accommodate his conversion unit. Just think — no gasoline fumes and no pollution. Cold air recycling through the engine can be used to air-condition the car.

Rogers said he can guarantee the engine for 23 million hours, or 30 years.

"Maintenance? The only requirement is frequent oil changes, tire maintenance and regular brake checks. He also claims that rings and valves could last two to three times longer because there is nothing to foul them.

" 'This could turn our country around,' Rogers said in the Bulletin story. . . .

"Rogers' wife, Betty, admitted that she did not believe her husband until she and a neighbor rode in the car.

" 'We didn't realize how important this is until we came back and sat down and realized we had ridden in a car that wasn't using gas,' she said. The toughest part of their discovery, she added, has been convincing people that it really works.

"Rogers has patented both the engine in the station wagon and another whole engine and transmission to protect himself.

"Rogers, the story went on, claimed that production of the conversion kits could produce about 3,000 units a day and be available to the public at $800 to $1,000 apiece. . . .

"Rogers said that if he doesn't get support, he will market the idea himself. Nelson said Rogers wants to help the working man in his constant fight against soaring oil prices . . . 'I hope he doesn't sell out to some car firm which just might put the idea on a back shelf; I don't think he will,' Nelson added. . . " OK, Cliff Greenman, that's the story.

What does it blow down to?

Is all this air news cause for a new air of excitement on your part, not to mention the rest of us pump-price-plagued gasoline users?

Or maybe just hot air?

Readers forum

In the Spotlight!

OBSESSED, COMPRESSED AND DEPRESSED. A Florida inventor has allegedly been offered a billion dollars by the big three automakers for absolute patent rights to an autombile engine which runs on compressed air. Lee Rogers of Iona converted his 1977 Dodge to run on compressed air only. He's obsessed with making the idea available to the general public, and depressed about the possibility of the automakers keeping the idea a secret should he sell it tp them. He and his neighbor are planning to manufacture a conversion kit which will "fit any American car." Meanwhile, he is working in secret, has an unlisted phone number and doesn't receive visitors — on the advice of his attorney.

Reprinted from Spotlight, 6/20/80

The Lakeland Times, 10-8-81

Finds air car far beyond expectations

BY TOM HOLLATZ

Air Car update!

I received a letter the other day from Lee Rogers of Ft. Myers, Fla. Rogers, you may remember, has invented a car that runs on air. Sounds crazy, right?

I thought so too until I interviewed Rogers in Ft. Myers Beach last March.

Rogers' letter dated Sept. 20, 1981, forwards a report on the air car as reviewed by Glynn Raymond Wiggins, who has a list of credentials as long as Hwy. 51. Wiggins lives in Hendersonville, Tenn., and recently stayed with Rogers, inspecting Rogers car, seeing if it is what Rogers claims– an air car running on nothing but air.

After Wiggins' review of the air car, Rogers wrote "we are proceeding and hopefully will be marketing my invention soon."

Wiggins in his report states that he visited Rogers in Ft. Myers, Fla., on June 11, 1981. He spent seven hours looking at Rogers' fantastic project in three stages – static observation, power observation and discussion/-analysis.

Wiggins writes: "My first contact with the air-powered engine was to see it mounted on a conventional Vega automobile equipped with a standard four-cylinder gasoline engine. I observed that all gasoline induction components had been removed and had been replaced by the air induction kit which Mr. Rogers developed.

"I was impressed by the absence of the cooling system (radiator, water pump, etc.). I took adequate time to explore the newly installed items, their necessary fittings and brackets, the compressed air source and exhaust system. The observation was accompanied by my questions, which Mr. Rogers answered to my complete satisfaction.

"My next level of concern was to observe the engine in operation. The engine was started with the automobile's own electric starter. Mr. Rogers operated the throttle (the valve on the compressed air tank) while I observed the engine's operation. I concentrated on engine temperature, vibration and noise level during the first run. The air supply lines to the cylinders were cool, the engine block appeared to be at room temperature and the exhaust was very cool.

"After a 3-5 minute run, the exhaust system was cool as a normally refrigerated item of 40 to 50 degrees F., and we were operating in a garage of about 85 to 90 degrees F. There was negligible vibration. However, with a straight exhaust, it had less noise than a lawnmower.

"We stopped the engine and restarted it four or five times within a 30 to 40-minute time span, as I continued to observe its operation and question Mr. Rogers. My final observation centered around the air intake and the exhaust. The engine has a tremendous and powerful exhaust and, of course, a huge volume of air intake. I was not able to overcome the exhaust pressure with my hand as I had done on many gasoline engines.

"After my live observation, Mr. Rogers and I discussed my impressions of the engine. I found it to be far beyond my expectations. I find it simple, powerful, quiet running and with low maintenance requirements. After considerable study, I detect no mechanical deficiencies or contradictions to the inventor's claims. Every component I have observed is completely feasible.

"I recommend its development without reservation."

The ramifications of Rogers' air-powered engine are vast. Air and not expensive fossil fuel is used. Rogers told the Times last March that he turned down over $1 billion from a representative of the three large U.S. automakers for his invention. He declined. One of the reasons he hasn't "sold out," he said, is because if he did so his invention may never be seen again.

Rogers hopes to market his own invention and sell air-car kits for around $1,000, he said. "I'd be letting too many people down if I went back on my word," Rogers said. Rogers, who is quite handy with gadgets and tools, developed the air-car process while tinkering. His wife didn't believe it until she saw him driving down the street in an air-powered car. It runs on air, he claims.

If all things are true in this amazing story, just think what it means for all Americans– and the world, too. Home generators that can provide free electricity is only the tip of the iceberg. Outboard motors, snowmobiles, airplanes– you name it– if it's powered by an engine, Rogers' development should work.

Times' readers wishing to write Rogers can do so at Post Office Box 3077, Ft. Myers Beach, Fla., 33931.

Ft. Myers is the former winter home of that great American genius Thomas A. Edison. It is ironic that Rogers, too, loves Ft. Myers. He told the Times that the future money his invention will bring doesn't phase him one bit. It will only mean more worries including body guards and body guards to watch the body guards.

That will come, but right now Rogers is working on final plans to market his invention.

Gentlemen, January 13, 1981

Thank you for your inquiry with regard to my fuelless conversion kit. I apologize for the delay in answering your letter.

I am currently negotiating to place the conversion kits for the air-car on the market. Two corporations have been established in the State of Florida and are proceeding to begin production of the air-car soon.

Your continued interest is greatly appreciated and I shall keep you informed of my progress.

Very truly yours,

ROGERS FUELLESS CONVERSION KIT, INC.

Leroy K. Rogers, Sr.
President
+97 7641 (813)

'Air car' develops complications

The Lakeland Times
1982?

BY TOM HOLLATZ

"What happened to that air car?"

That is one of the most frequently asked questions by Times' readers.

Some time ago we told about an air car invented by Lee Rogers of Ft. Myers Beach, Fla. Rogers designed an automobile engine that is powered by compressed air, which he has patented.

Converted from a 318-cubic inch Chrysler engine in a 1977 Dodge Aspen station wagon, the motor is driven by compressed air forcing the pistons up and down in the same manner as gasoline drives an internal combustion engine. Once the engine is primed with compressed air, it runs on a self-sustained cycle that "you could drive anywhere in the country without stopping if you wanted to," according to Rogers who was quoted in a Florida newspaper.

However, some complications have developed with Rogers' air engine, the Times has learned. Rogers is quoted in an interview in Consumers' Guide that there is a slight compressor problem,

At low speeds all the air was used up within 20 minutes, Rogers said. At speeds of 5 to 15 miles per hour the engine doesn't run fast enough to rebuild the air supply in the compressor tanks. Rogers said he needs 2,000 rpms to remake the car's air supply and that's the current problem.

However, Rogers is confident he can solve the problem. "It's a matter of gearing and some slight problems...I am very close to solving the problem." The article also goes on to say that when Rogers solves his problem that his invention is on a verge of causing complete havoc in the automotive world.

One Presque Isle reader told the Times, "I hope Mr. Rogers doesn't sell out to the oil and auto giants." He also said on Monday, Aug. 18, "Call me if it comes to Minocqua. I would like to see it."

So would 230 million Americans!

Rogers' $7,000 brainstorm has been approached skeptically, by Chrysler, Ford and General Motors.

The engine is basically a very simple idea. The engine has been converted to house eight air hoses going into each of the eight cylinders from a "distribution block", which sits atop the engine block. The compressor sits forward of the distribution block and controls the volume of air being forced into the engine, which in turn controls the speed of the vehicle. Two gauges on the dashboard show the driver the pressure in the air tanks (which can be placed where the conventional gasoline tanks usually are) and the pressure of the air being forced through the engine.

Rogers' invention, if true, would ignite an automotive revolution not seen in the world since Henry Ford started mass producing the Model T car.

And now the good part. The "air" car doesn't have a gasoline tank, carburetor, fuel pump, spark plugs, points, and condenser. Also removed was the entire exhaust system to accommodate his conversion unit. There are no gasoline fumes. Cold air recycling through the engine can be used to air condition the engine.

Maintenance would require infrequent oil changes, tire maintenance and regular brake checks. Rings and valves could last two to three times longer because there is nothing the foul them, Rogers said.

The father of a Minocqua resident Mrs. Ron Nelson at the Motel Minocqua on Hwy. 51 has reportedly seen the new air car. Her father is a resident of Ft. Myers Beach.

In the Consumer Guides interview, Rogers expressed some concern that his personal life is being "bothered" by hundreds of letters from persons interested in his invention. He wants his privacy and a normal life.

Mrs. Nelson told the Times that several people have called from all over the state wanting to give her money so she could buy air conversion kits for them. The air conversion kits are not ready for sale at this point in time.

In an effort to give Rogers some peace and quiet, letters concerning the air-powered engine should be addressed to: Consumers' Guide, co Lee Rogers, P.O. Box 2700, Toledo, Ohio, 43606.

In an earlier interview, Rogers claimed that production of the conversion kits could produce 3,000 units a day and be available to the public at $800 to $1,000 apiece. Rogers apparently wants to keep his invention out of the hands of the oil moguls.

The potential of such an air engine is unlimited. In theory, it could power snowmobiles, outboard motors, tractors, home electrical generators and the list goes on and on. It could also power an electric sign or two on New York's Times Square which could, via flashing lights, tell the OPEC nations what to do with their over-priced oil.

Stay tuned!

United States Patent [19] | [11] 4,292,804
Rogers, Sr. | [45] Oct. 6, 1981

[54] **METHOD AND APPARATUS FOR OPERATING AN ENGINE ON COMPRESSED GAS**

[76] Inventor: **Leroy K. Rogers, Sr.**, #5 Capistrano Ct., Ft. Myers, Fla. 33908

[21] Appl. No.: **158,303**

[22] Filed: **Jun. 10, 1980**

[51] **Int. Cl.**[3] **F15B 11/06**

[52] **U.S. Cl.** **60/407**; 91/187; 91/275

[58] **Field of Search** 60/407, 412; 91/187, 91/275, 364

[56] **References Cited**

U.S. PATENT DOCUMENTS

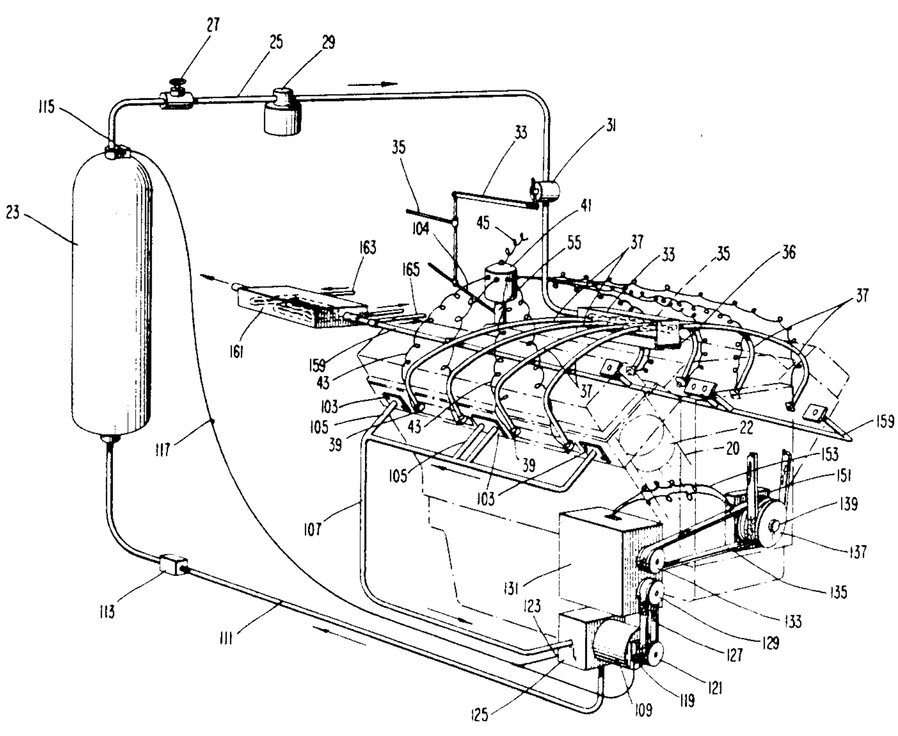
3,881,399	5/1975	Sagi et al.	91/187 X
3,885,387	5/1975	Simington	60/407 X
4,018,050	4/1977	Murphy	60/412 X

Primary Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—Burns, Doane, Swecker & Mathis

[57] **ABSTRACT**

The present invention relates to a method and apparatus for operating an engine having a cylinder and a piston reciprocable therein on compressed gas. The apparatus comprises a source of compressed gas connected to a distributor which distributes the compressed gas to the cylinder. A valve is provided to selectively admit compressed gas to the cylinder when the piston is in an approximately top dead center position. In one embodiment of the present invention the timing of the opening of the valve is advanced such that the compressed gas is admitted to the cylinder progressively further before the top dead center position of the piston as the speed of the engine increases. In a further embodiment of the present invention a valve actuator is provided which increases the length of time over which the valve remains open to admit compressed gas to the cylinder as the speed of the engine increases. A still further embodiment of the present invention relates to an apparatus for adapting a conventional internal combustion engine for operation on compressed gas.

22 Claims, 8 Drawing Figures



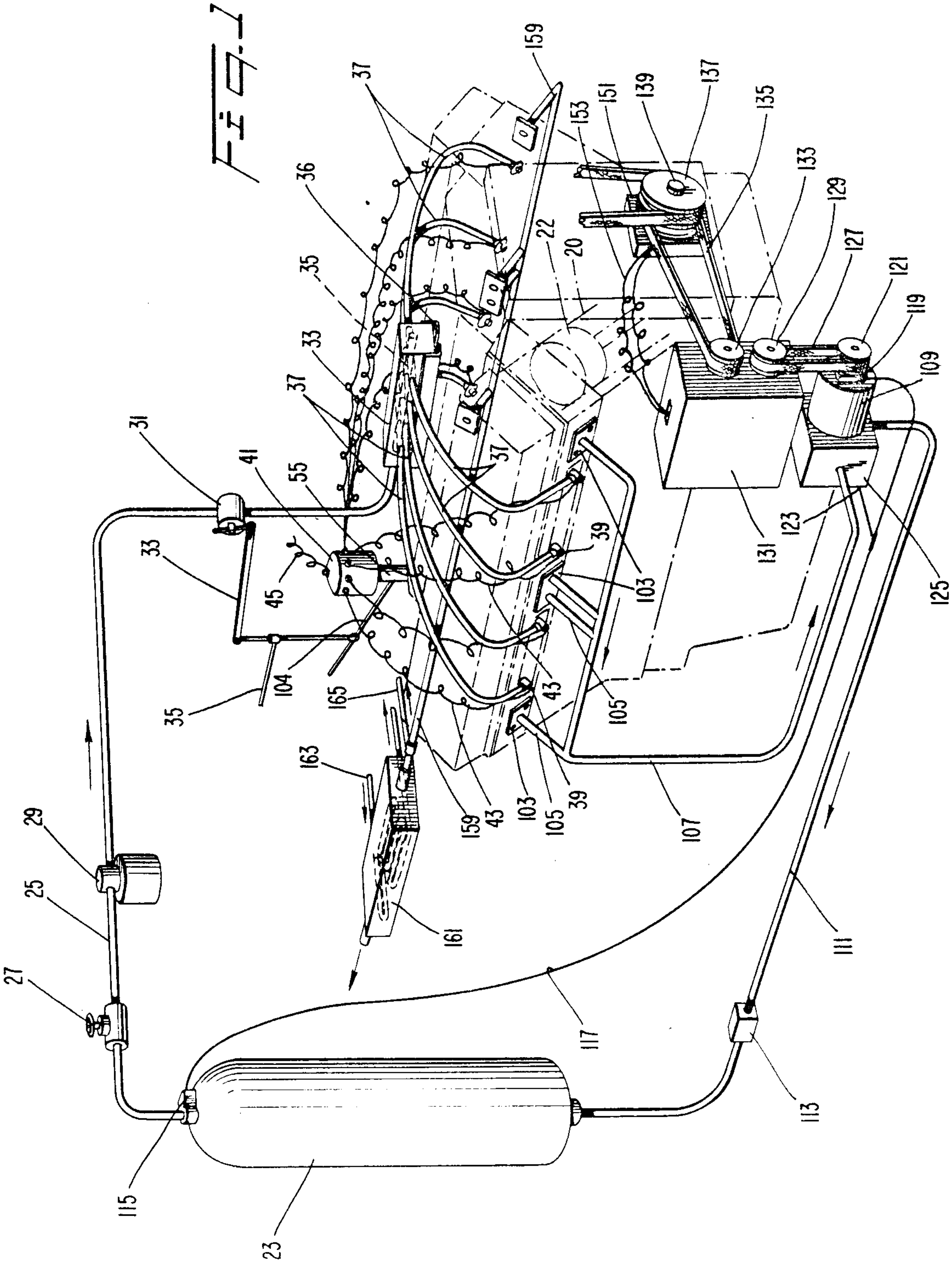


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FIG. 1

FIG. 6

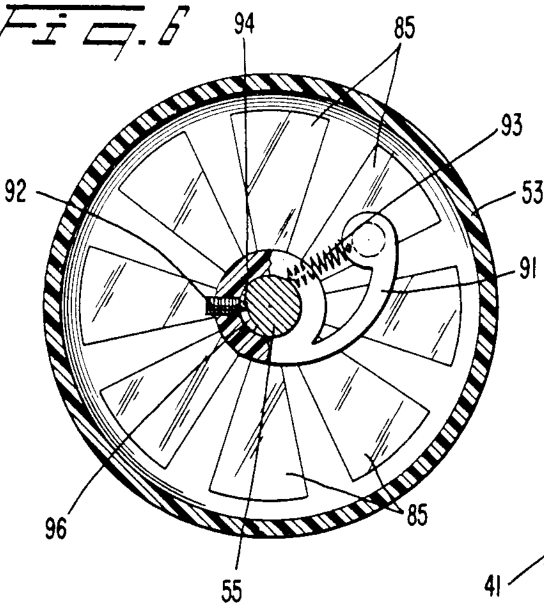
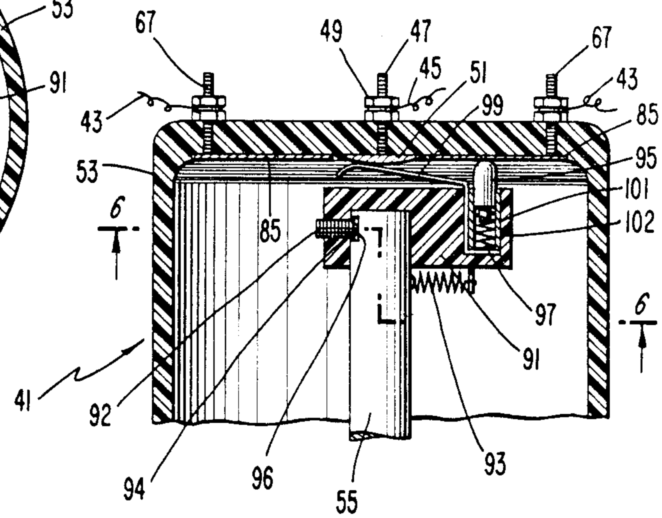


FIG. 7



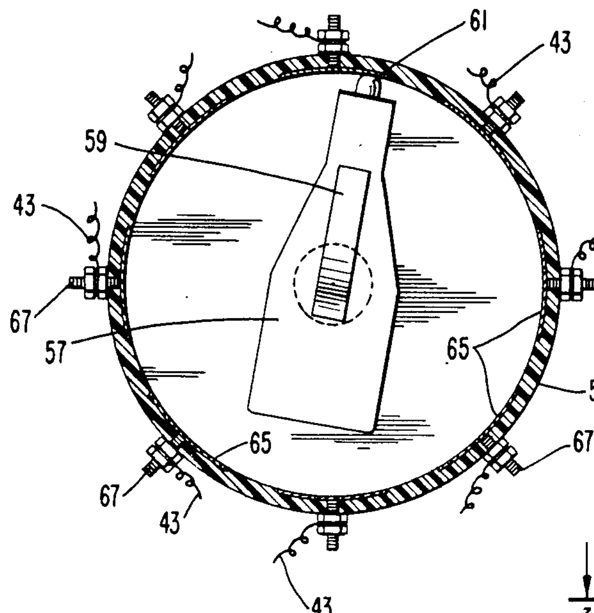


FIG. 3

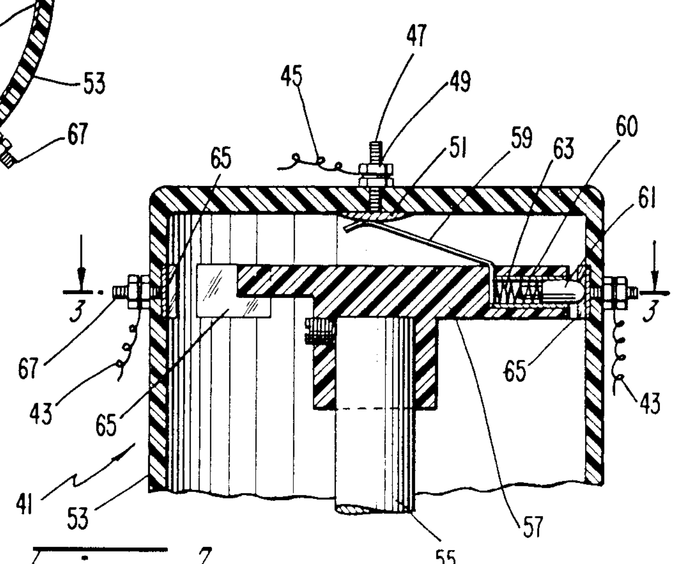


FIG. 2

Fig. 5

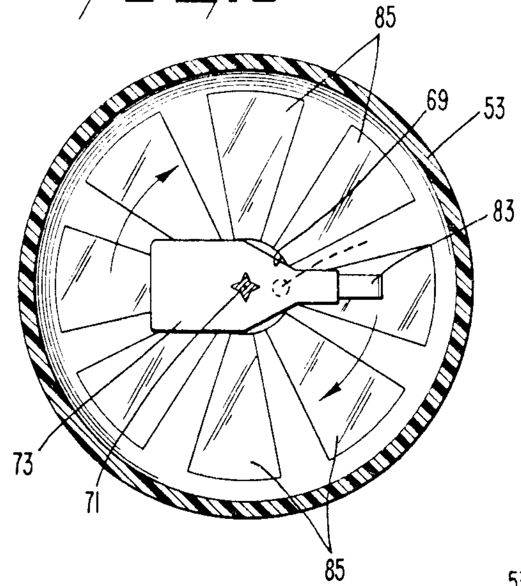


Fig. 4

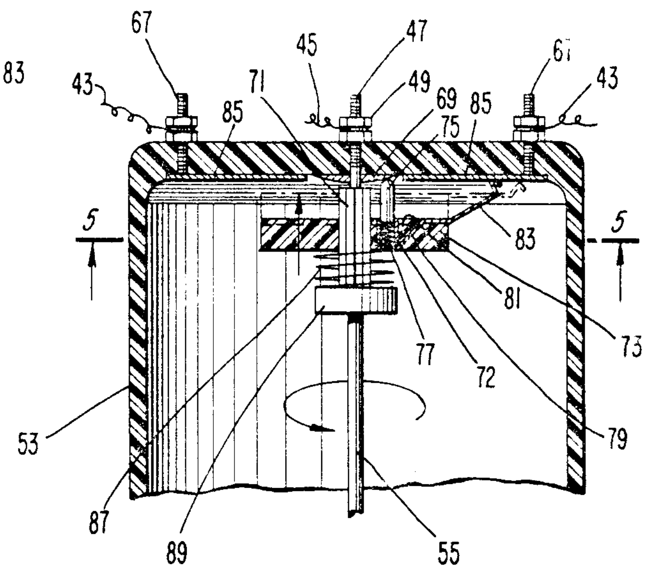
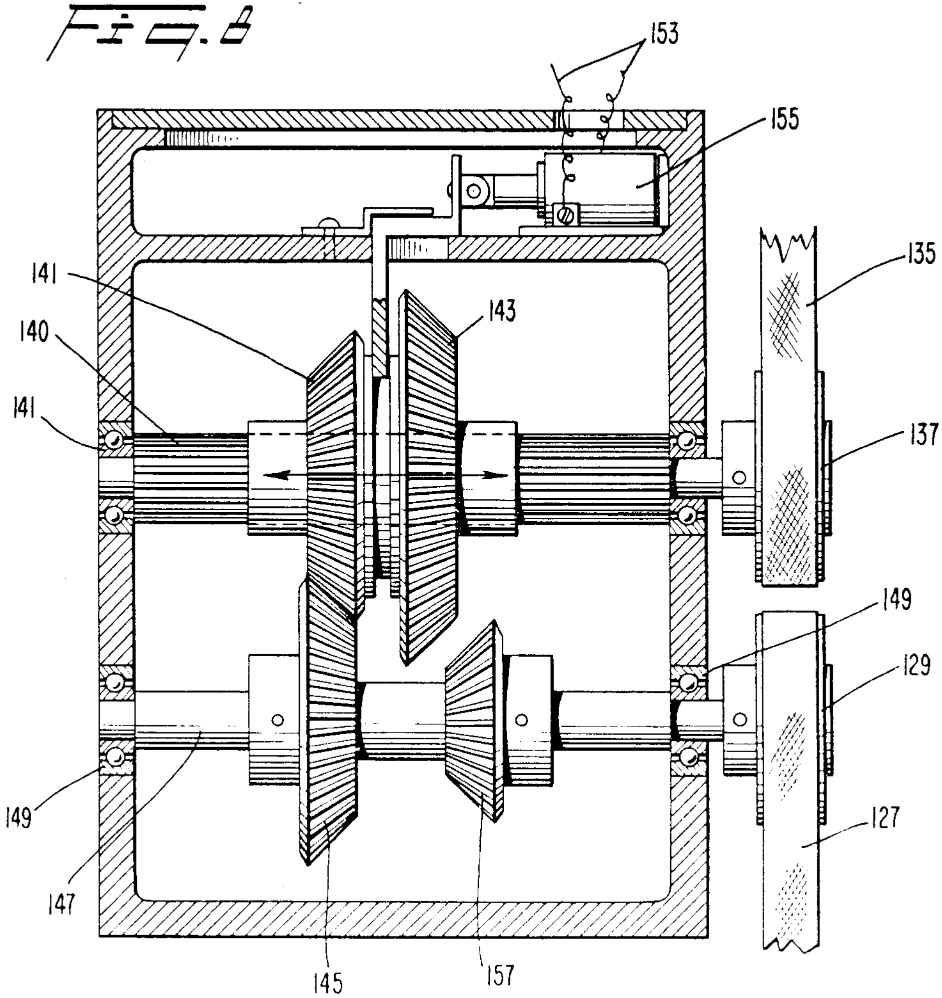


Fig. 8



METHOD AND APPARATUS FOR OPERATING AN ENGINE ON COMPRESSED GAS

BACKGROUND AND SUMMARY OF THE PRESENT INVENTION

The present invention relates to a method and apparatus for operating an engine using a compressed gas as the motive fluid. More particularly, the present invention relates to a apparatus for adapting a pre-existing internal combustion engine for operation on a compressed gas.

Air pollution is one of the most serious problems facing the world today. One of the major contributors to air pollution is ordinary internal combustion engine which are used in most motor vehicles today. Various devices, including many items mandated by legislation, have been proposed in an attempt to limit the pollutants which an internal combustion engine exhausts to the air. However, most of these devices have met with limited success and are often both prohibitively expensive and complex. A clean alternative to the internal combustion engine is needed to power vehicles and other machinery.

A compressed gas, preferably air, would provide an ideal motive fluid for a engine since it would eliminate the usual pollutants exhausted from an internal combustion engine. An apparatus for converting an internal combustion engine for operation on compressed air is disclosed in U.S. Pat. No. 3,885,387 issued May 27, 1975 to Simington. The Simington patent discloses an apparatus including a source of compressed air and a rotating valve actuator which opens and closes a plurality of mechanical poppet valves. The valves deliver compressed air in timed sequence to the cylinders of an engine through adapters located in the spark plug holes. However, the output speed of an engine of this type is limited by the speed of the mechanical valves and the fact that the length of time over which each of the valves remains open cannot be varied as the speed of the engine increases.

Another apparatus for converting an internal combustion engine for operation on steam or compressed air is disclosed in U.S. Pat. No. 4,102,130 issued July 25, 1978 to Stricklin. The Stricklin patent discloses a device which changes the valve timing of a conventional four stroke engine such that the intake and exhaust valves open once for every revolution of the engine instead of once every other revolution of the engine. A reversing valve is provided which delivers live steam or compressed air to the intake valves and is subsequently reversed to allow the exhaust valves to deliver the expanded steam or air to the atmosphere. A reversing valve of this type however does not provide a reliable apparatus for varying the amount of motive fluid injected into the cylinders when it is desired to increase the speed of the engine. Further, a device of the type disclosed in the Stricklin patent requires the use of multiple reversing valves if the cylinders in a multi-cylinder engine were to be fired sequentially.

Therefore, it is an object of the present invention to provide a reliable method and apparatus for operating an engine or converting an engine for operation with a compressed gas.

A further object of the present invention is to provide a method and apparatus which is effective to deliver a constantly increasing amount of compressed gas to an engine as the speed of the engine increases.

A still further object of the present invention is to provide a method and apparatus which will operate an engine using compressed gas at a speed sufficient to drive a conventional automobile at highway speeds.

It is still a further object of the present invention to provide a method and apparatus which is readily adaptable to a standard internal combustion engine to convert the internal combustion engine for operation with a compressed gas.

Another object of the invention is to provide a method and apparatus which utilizes cool expanded gas, exhausted from a compressed gas engine, to operate an air conditioning unit and/or an oil cooler.

These and other objects are realized by a method and apparatus according to the present invention for operating an engine having at least one cylinder and a reciprocating piston therein using compressed gas as a motive fluid. The apparatus includes a source of compressed gas and a distributor connected with the source of the compressed gas for distributing the compressed gas to the at least one cylinder. A valve is provided for admitting the compressed gas to the cylinder when the piston is in approximately a top dead center position within the cylinder. An exhaust is provided for exhausting the expanded gas from the cylinder as the piston returns to approximately the top dead center position.

In a preferred embodiment of the present invention a device is provided for varying the duration of each engine cycle over which the valve remains open to admit compressed gas to the cylinder dependent upon the speed of the engine. In a further preferred embodiment of the present invention, an apparatus for advancing the timing of the opening of the valve is arranged to admit the compressed gas to the cylinder progressively further before the top dead center position of the piston as the speed of the engine increases.

Further features of the present invention include a valve for controlling the amount of compressed gas admitted to the distributor. Also, a portion of the gas which has been expanded in the cylinder and exhausted through the exhaust valve is delivered to a compressor to be recompressed and returned to the source of compressed gas. A gear train is selectively engagable to drive the compressor at different operating speed depending upon the pressure maintained at the source of compressed air and/or the speed of the engine. Still further, a second portion of the exhaust gas is used to cool a lubricating fluid for the engine or to operate an air conditioning unit.

In a preferred embodiment of the present invention, the valve for admitting compressed gas to the cylinder is electrically actuated. The device for varying the duration of each engine cycle over which the intake valve remains open as the speed of the engine increase comprises a rotating element whose effective length increases as the speed of the engine increases such that a first contact on the rotating element is electrically connected to a second contact for a longer period of each engine cycle. The second contact actuates the valve whereby the valve remains in an open position for a longer period of each engine cycle as the speed of the engine increases.

Still further features of the present invention include an adaptor plate for supporting the distributor above an intake manifold of a conventional internal combustion engine after a carburetor has been removed to allow air

to enter the cylinders of the engine through the intake manifold and conventional intake valves. Another adaptor plate is arranged over an exhaust passageway of the internal combustion engine to reduce the cross-sectional area of the exhaust passageway.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of a method and apparatus for operating an engine according to the present invention will be described with reference to the accompanying drawings wherein like members bear like reference numerals and wherein:

FIG. 1 is a schematic representation of an apparatus according to the present invention arranged on an engine.

FIG. 2 is a side view of one embodiment of a valve actuator according to the present invention;

FIG. 3 is a cross-sectional view taken along the line 3—3 in FIG. 2;

FIG. 4 is a cross-sectional view of a second embodiment of a valve actuator according to the present invention;

FIG. 5 is a view taken along the line 5—5 in FIG. 4;

FIG. 6 is a cross-sectional view of a third embodiment of a valve actuator according to the present invention;

FIG. 7 is a view taken along the line 7—7 in FIG. 6;

FIG. 8 is a cross-sectional view of a gearing unit to drive a compressor according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, an engine block **21** (shown in phantom) having two banks of cylinders with each bank including cylinders **20** having pistons **22** reciprocable therein (only one of which is shown in phantom) in a conventional manner. While the illustrated engine is a V-8 engine, it will be apparent that the present invention is applicable to an engine having any number of pistons and cylinders with the V-8 engine being utilized for illustration purposes only. A compressed gas tank **23** is provided to store a compressed gas at high pressure. It may also be desirable to include a small electric or gas compressor to provide compressed gas to supplement the compressed gas held in the tank **23**. In a preferred embodiment, the compressed gas is air which can be obtained from any suitable source.

A line **25** transports the gas withdrawn from the tank **23** when a conventional shut off valve **27** is open. In addition, a solenoid valve **29** preferably operated by a suitable key operated switch (not shown) for the engine is also arranged in the line **25**. In normal operation, the valve **27** is maintained open at all times with the solenoid valve **29** operating as a selective shut off valve to start and stop the engine **21** of the present invention.

A suitable regulating valve **31** is arranged downstream from the solenoid valve **29** and is connected by a linkage **33** to a throttle linkage **35** which is operator actuated by any suitable apparatus such as a foot pedal (not shown). The line **25** enters an end of a distributor **33** and is connected to an end of a pipe **35** which is closed at the other end. A plurality of holes, which are equal to the number of cylinders in the engine **21**, are provided on either side of the pipe **35** along the length of the pipe **35**.

When the present invention is used to adapt a conventional internal combustion engine for operation on compressed gas, an adaptor plate **36** is provided to support the distributor **33** in spaced relation from the usual intake opening in the intake manifold of the engine after a conventional carburetor has been removed. In this way, air is permitted to enter the internal combustion engine through the usual passageways and to be admitted to the cylinders through suitable intake valves (not shown). The adaptor plate **36** is secured to the engine block **21** and the distributor **33** by any suitable apparatus, e.g., bolts.

Each of the holes in the pipe **35** is connected in fluid-tight manner to a single line **37**. Each line **37** carries the compressed gas to a single cylinder **20**. In a preferred embodiment, each of the lines **37** is $\frac{1}{8}$ inch high pressure plastic tubing attached through suitable connectors to the distributor **33** and the pipe **35**. Each of the lines **37** is connected to a valve **39** which is secured in an opening provided near the top of each of the cylinders **20**. In the case of a conversion of a standard internal combustion engine, the valves **39** can be conveniently screwed into a tapped hole in the cylinder **20** typically provided for a spark plug of the internal combustion engine. In a preferred embodiment, the valves **39** are solenoid actuated valves in order to provide a fast and reliable opening and closing of the valves **39**.

Each of the valves **39** is energized by a valve actuator **41** through one of a plurality of wires **43**. The valve actuator **41** is driven by a shaft of the engine similar to the drive for a conventional distributor of an internal combustion engine. That is, a shaft **55** of the valve actuator **41** is driven in synchronism with the engine **21** at one half the speed of the engine **21**.

A first embodiment of the valve actuator **41** (FIGS. **2** and **3**) receives electrical power through a wire **45** which is energized in a suitable manner by a battery, and a coil if necessary (not shown) as is conventional in an internal combustion engine. The wire **45** is attached to a central post **47** by a nut **49**. The post **47** is connected to a conducting plate **51** arranged within a housing **53** for the valve actuator **41**. Within the housing **53**, the shaft **55** has an insulating element **57** secured to an end of the shaft **55** for co-rotation therewith when the shaft **55** is driven by the engine **21**. A first end of a flexible contact **59** is continuously biased against the conducting plate **51** to receive electricity from the battery or another suitable source. A second end of the contact **59** is connected to a conducting sleeve **60** which is in constant contact with a spring biased contact **61** which is arranged within the sleeve **60**. The contact **61** is biased by a spring **63** which urges the contact **61** towards a side wall of the housing **53**.

With reference to FIG. **3**, a plurality of contacts **65** are spaced from one another and are arranged around the periphery of the housing **53** at the same level as the spring biased contact **61**. Each contact **65** is electrically connected to a post **67** which extends outside of the housing **53**. The number of contacts **65** is equal to the number of cylinders in the engine **21**. One of the wires **43**, which actuate the valves **39**, is secured to each of the posts **67**.

In operation, as the shaft **55** rotates in synchronism with the engine **21**, the insulating element **57** rotates and electricity is ultimately delivered to successive ones of the contacts **65** and wires **43** through the spring biased contact **61** and the flexible contact **59**. In this way, each of the electrical valves **39** is actuated and opened in the proper timed sequence to admit compressed gas to each of the cylinders **20** to drive the pistons **22** therein on a downward stroke.

The embodiment illustrated in FIGS. 2 and 3 is effective to actuate each of the valves 39 to remain open for a long enough period of time to admit sufficient compressed gas to each of the cylinders 20 of the engine 21 to drive the engine 21. The length of each of the contacts 65 around the periphery of the housing 53 is sufficient to permit the speed of the engine to be increased when desired by the operator by moving the throttle linkage 35 which actuates the linkage 33 to further open the regulating valve 31 to admit more compressed gas from the tank 23 to the distributor 33. However, it has been found that the amount of air admitted by the valves 39 when using the first embodiment of the valve actuator 41 (FIGS. 2 and 3) is substantially more than required to operate the engine 21 at an idling speed. Therefore, it may be desirable to provide a valve actuator 41 which is capable of varying the duration of each engine cycle over which the solenoid valves 39 are actuated, i.e., remain open to admit compressed gas, as the speed of the engine 21 is varied.

A second embodiment of a valve actuator 41 which is capable of varying the duration of each engine cycle over which each of the valves 39 remains open to admit compressed gas to the cylinders 20 dependent upon the speed of the engine 21 will be described with reference to FIGS. 4 and 5 wherein members corresponding to those of FIGS. 2 and 3 bear like reference numerals. The wire 45 from the electrical source is secured to the post 47 by the nut 49. The post 47 has a annular contact ring 69 electrically connected to an end of the post 47 and arranged within the housing 53. The shaft 55 rotates at one half the speed of the engine as in the embodiment of FIGS. 2 and 3.

At an upper end of the shaft 55, a splined section 71 slidably receives an insulating member 73. The splined section 71 of the shaft 55 positively holds the insulating member 73 for co-rotation therewith but permits the insulating member 73 to slide axially along the length of the splined section 71. Near the shaft 55, a conductive sleeve 72 is arranged in a bore 81 in an upper surface of the insulating element 73 generally parallel to the splined section 71. A contact 75, biased towards the annular contact ring 69 by a spring 77, is arranged within the conductive sleeve 72 in contact therewith. The conductive sleeve 72 also contacts a conductor 79 at a base of the bore 81.

The conductor 79 extends to the upper surface of the insulating element 73 near an outer periphery of the insulating element 73 where the conductor 79 is electrically connected to a flexible contact 83. The flexible contact 83 selectively engages a plurality of radial contacts 85 arranged on an upper inside surface of the housing 53. A weak spring 87 arranged around the splined section 71 engages a stop member 89 secured on the shaft 55 and the insulating element 73 to slightly bias the insulating element 73 towards the upper inside surface of the housing 53 to ensure contact between the flexible contact 83 and the upper inside surface of the housing 53. As best seen in FIG. 5, the radial contacts 85 on the upper inside surface of the housing 53 are arranged generally in the form of radial spokes extending from the center of the housing 53 with the number of contacts being equal to the number of cylinders 20 in the engine 21. The number of degrees covered by each of the radial contacts 85 gradually increases as the distance from the center of the upper inside surface of the housing 53 increases.

In operation of the device of FIGS. 4 and 5, as the shaft 55 rotates, electricity flows along a path through the wire 45 down through post 47 to the annular contact member 69 which is in constant contact with the spring biased contact 75. The electrical current passes through the conductive sleeve 72 to the conductor 79 and then to the flexible contact 83. As the flexible contact 83 rotates along with the insulating member 73 and the shaft 55, the tip of the flexible contact 83 successively engages each of the radial contacts 85 on the upper inside of the housing 53. As the speed of the shaft 55 increases, the insulating member 73 and the flexible contact 83 attached thereto move upwardly along the splined section 71 of the shaft 55 due to the radial component of the splines in the direction of rotation under the influence of centrifugal force. As the insulating member 73 moves upwardly, the flexible contact 83 is bent such that the tip of the contact 83 extends further radially outwardly from the center of the housing 53 (as seen in phantom lines in FIG. 4). In other words, the effective length of the flexible contact 83 increases as the speed of the engine 21 increases.

As the flexible contact 83 is bent and the tip of the contact 83 moves outwardly, the tip remains in contact with each of the radial contacts 85 for a longer period of each engine cycle due to the increased angular width of the radial contacts with increasing distance from the center of the housing 53. In this way, the length of time over which each of the valves 39 remains open is increased as the speed of the engine is increased. Thus, a larger quantity of compressed gas or air is injected into the cylinders as the speed increases. Conversely, as the speed decreases and the insulating member 73 moves downwardly along the splined section 71, a minimum quantity of air is injected into the cylinder due to the shorter length of the individual radial contact 85 which is in contact with the flexible contact 83. In this way, the amount of compressed gas that is used during idling of the engine 21 is at a minimum whereas the amount of compressed gas which is required to increase the speed of the engine 21 to a level suitable to drive a vehicle on a highway is readily available.

With reference to FIGS. 6 and 7, a third embodiment of a valve actuator 41 according to the present invention includes an arcuate insulating element 91 having a first end pivotally secured by any suitable device such as screw 92 to the shaft 55 for co-rotation with the shaft 55. The screw 92 is screwed into a tapped hole in the insulating element 91 such that a tab 94 at an end of the screw 92 engages a groove 96 provided in the shaft 55. In this way, the insulating element 91 positively rotates with the shaft 55. However, as the shaft 55 rotates faster, a second end 98 of the insulating element 91 is permitted to pivot outwardly under the influence of centrifugal force because of the groove 96 provided in the shaft 55. A spring 93 connected between the second end 98 of the element 91 and the shaft 55 urges the second end of the element 91 towards the center of the housing 53.

A contact 99 similar to the contact 59 (FIG. 2) is arranged such that one end of the contact 99 is in constant contact with the conducting plate 51 located centrally within the housing 53. The other end of the contact 99 engages a conductive sleeve 101 arranged in bore 102. A contact element 95 is arranged in the conductive sleeve 101 in constant contact with the sleeve 101. The bore 102 is arranged generally parallel to the shaft 55 near the second end of the arcuate insulating

element 91. The contact 95 is biased by a spring 97 towards the upper inside surface of the housing 53 for selective contact with each of the plurality of radial contacts 85 which increase in arc length towards the outer peripheral surface of the housing 53 (FIG. 6).

In operation of the device of FIGS. 6 and 7, as the shaft 55 rotates the arcuate insulating element 91 rotates with the shaft 55 and the second end 98 of the insulating element 91 tends to pivot about the shaft 55 due to centrifugal force. Thus, as the effective length of the contact 95 increases, i.e., as the arcuate insulating element 91 pivots further outwardly, the number of degrees of rotation over which the contact 95 is in contact with each of the radial contacts 85 on the upper inside surface of the housing 53 increases thereby permitting each of the valves 39 to remain open for a longer period of each engine cycle to admit more compressed gas to the respective cylinder 20 to further increase the speed of the engine 21.

With reference to FIG. 1, a mechanical advance linkage 104 which is connected to the throttle linkage 35, advances the initiation of the opening of each valve 39 such that compressed gas is injected into the respective cylinder further before the piston 22 in the respective cylinder 20 reaches a top dead center position as the speed of the engine is increased by moving the throttle linkage 35. The advance linkage 104 is similar to a conventional standard mechanical advance employed on an internal combustion engine. In other words, the linkage 104 varies the relationship between the angular positions of a point on the shaft 55 and a point on the housing 53 containing the contacts. Alternatively, a conventional vacuum advance could also be employed. By advancing the timing of the opening of the valves 39, the speed of the engine can more easily be increased.

The operation of the engine cycle according to the present invention will now be described. The compressed gas injected into each cylinder of the engine 21 drives the respective piston 22 downward to drive a conventional crankshaft (not shown). The movement of the piston downwardly causes the compressed gas to expand rapidly and cool. As the piston 22 begins to move upwardly in the cylinder 20 a suitable exhaust valve (not shown) arranged to close an exhaust passageway is opened by any suitable apparatus. The expanded gas is then expelled through the exhaust passageway. As the piston 22 again begins to move downwardly a suitable intake valve opens to admit ambient air to the cylinder. The intake valve closes and the ambient air is compressed on the subsequent upward movement of the piston until the piston reaches approximately the top dead center position at which time the compressed gas is again injected into the cylinder 20 to drive the piston 22 downward and the cycle begins anew.

In the case of adapting a conventional internal combustion engine for operation on compressed gas, a plurality of plates 103 are preferably arranged over an end of the exhaust passageways in order to reduce the outlet size of the exhaust passageways of the conventional internal combustion engine. In the illustrated embodiment, a single plate having an opening in the center is bolted to the outside exhaust passageway on each bank of the V-8 engine while another single plate having two openings therein is arranged with one opening over each of the interior exhaust passageways on each bank of the V-8 engine. A line 105 is suitably attached to each of the adaptor places to carry the exhaust to an appropriate location. In a preferred embodiment, the exhaust lines 105 are 1½" plastic tubing.

In a preferred embodiment, the exhaust lines 105 of one bank of the V-8 engine are collected in a line 107 and fed to an inlet of a compressor 109. The pressure of the exhaust gas emmanating from the engine 21 according to the present invention is approximately 25 p.s.i. In this way, the compressor 109 does not have to pull the exhaust into the compressor since the gas exhausted from the engine 21 is at a positive pressure. The positive pressure of the incoming fluid increases the efficiency and reduces wear on the compressor 109. The exhaust gas is compressed in the compressor 109 and returned through a line 111 and a check valve 113 to the compressed gas storage tank 23. The check valve 113 prevents the flow of compressed gas stored in the tank 23 back towards the compressor 109.

A suitable pressure sensor 115 is arranged at an upper end of the tank 23 and sends a signal along a line 117 when the pressure exceeds a predetermined level and when the pressure drops below a predetermined level. The line 117 controls an electrically actuated clutch 119 disposed at a front end of the compressor 109. The clutch 119 is operative to engage and disengage the compressor 109 from a drive pulley 121. Also, the signal carried by the line 117 actuates a suitable valve 123 arranged on a compressor housing 125 to exhaust the air entering the compressor housing 125 from the line 107 when the clutch 119 has disengaged the compressor 109 from the drive pully 121.

In a preferred embodiment, when the pressure is the tank 23 reaches approximately 600 p.s.i., the clutch 119 is disengaged and the compressor 109 is deactivated and the valve 123 is opened to exhaust the expanded gas delivered to the compressor 109 from the line 107 to the atmosphere. When the pressure within the tank 23 drops below approximately 500 p.s.i., the sensor 115 sends a signal to engage the clutch 119 and close the valve 123, thereby operating the compressor 109 for supplying the tank 23 with compressed gas.

The pulley 121 which drives the compressor 109 through the clutch 119 is driven by a belt 127 which is driven by a pulley 129 which operates through a gear box 131. With reference to FIGS. 1 and 8, a second pulley 133 on the gear box is driven by a belt 135 from a pulley 137 arranged on a drive shaft 139 of the engine 21. The pulley 137 drives a splined shaft 140 which has a first gear 141 and a second larger gear 143 arranged thereon for rotation with the splined shaft 140. The splined shaft 140 permits axial movement of the gears 141 and 143 along the shaft 140.

In normal operation (as seen in FIG. 8), the first gear 141 engages a third gear 145 arranged on a shaft 147 which drives the pulley 129. The shafts 140 and 147 are arranged in suitable bearings 149 arranged at each end thereof. When the speed of the engine 21 drops below a predetermined level, a suitable sensor 151 responsive to the speed of the drive shaft 139 of the engine 21 generates a signal which is transmitted through a line 153 to a solenoid actuator 155 arranged within the gear box 131. The solenoid actuator 155 moves the first and second gears 141, 143 axially along the splined shaft 140 to the right as seen in FIG. 8 such that the second, larger gear 143 engages a fourth smaller gear 157 which is arranged on the shaft 147. The ratio of the second gear 143 to the fourth gear 157 is preferably approximately 3 to 1.

In this way, when the speed of the engine **21** drops below the predetermined level as sensed by the sensor **151** (which predetermined level is insufficient to drive the compressor **109** at a speed sufficient to generate the 500–600 pounds of pressure which is preferably in the tank **23**), the solenoid actuator **155** is energized to slide the gears **143**, **141** axially along the splined shaft **140** so that the second, larger gear **143** engages the fourth, smaller gear **157** to drive the pulley **129** and hence the compressor **109** at a higher rate of speed to generate the desired pressure. When the speed of the engine increases above the predetermined level, in a preferred embodiment approximately 1500 rpm, the solenoid actuator **155** is deactivated by the sensor **151** thereby moving the gears **143** and **141** to the left as seen in FIG. **8** such that the first gear **141** re-engages with the third gear **145** to effectuate a 1 to 1 ratio between the output shaft **139** of the engine **21** and the pulley **129**.

The other bank of the V-8 engine has its exhaust ports arranged with adapter plates **103** similar to those on the first bank. However, the exhaust from this bank of the engine **21** is not collected and circulated through the compressor **109**. In a preferred embodiment, a portion of the exhaust is collected in a line **159** and fed to an enlarged chamber **161**. A second fluid is fed through a line **163** into the chamber **161** to be cooled by the cool exhaust emmanating from the engine **21** in the line **159**. The second fluid in the line **163** may be either transmission fluid contained in a transmission associated with the engine **21** or a portion of the oil used to lubricate the engine **21**. A second portion of the exhaust from the second bank of the V-8 engine is removed from the line **159** in a line **165** and used as a working fluid in an air conditioning system or for any other suitable use.

It should be noted that the particular arrangement utilized for collecting and distributing the gas exhausted from the engine **21** would be determined by the use for which the engine is employed. In other words, it may be advantageous to rearrange the exhaust tubing such that a larger or smaller percentage of the exhaust is routed through the compressor **109**. It should also be noted that since the exhaust lines **105** are plastic tubing, a rearrangement of the lines for a different purpose is both simple and inexpensive.

In operation of the engine of the present invention, the engine **21** is started by energizing the solenoid valve **29** and any suitable starting device (not shown), e.g., a conventional electric starter as used on an internal combustion engine. Compressed gas from the full tank **23** flows through the line **25** and a variable amount of the compressed gas is admitted to the distributor **33** by controlling the regulator valve **31** through the linkage **33** and the operator actuated throttle linkage **35**. The compressed gas is distributed to each of the lines **37** which lead to the individual cylinders **20**. The compressed gas is admitted to each of the cylinders **20** in timed relationship to the position of the pistons within the cylinders by opening the valves **39** with the valve actuator **41**.

When it is desired to increase the speed of the engine, the operator moves the throttle linkage **35** which simultaneously admits a larger quantity of compressed gas to the distributor **33** from the tank **23** by further opening the regulator valve **31**. The timing of the valve actuator **41** is also advanced through the linkage **104**. Still further, as the speed of the engine **21** increases, the effective length of the rotating contact **83** (FIG. **4**) or **95** (FIG. **6**) increases thereby electrically contacting a wider portion of one of the stationary radial contacts **85** to cause each of the valves **39** to remain open for a longer period of each engine cycle to admit a larger quantity of compressed gas to each of the cylinders **20**.

As can be seen, the combination of the regulating valve **31**, the mechanical advance **104**, and the valve actuator **41**, combine to produce a compressed gas engine which is quickly and efficiently adaptable to various operating speeds. However, all three of the controls need not be employed simultaneously. For example, the mechanical advance **104** could be utilized without the benefit of one of the varying valve actuators **41** but the high speed operation of the engine may not be as efficient. By increasing the duration of each engine cycle over which each of the valves **39** remains open to admit compressed gas to each of the cylinders **20** as the speed increases, conservation of compressed gas during low speed operation and efficient high speed operation are both possible.

After the compressed gas admitted to the cylinder **20** has forced the piston **22** downwardly within the cylinder to drive the shaft **139** of the engine, the piston **22** moves upwardly within the cylinder **20** and forces the expanded gas out through a suitable exhaust valve (not shown) through the adapter plate **103** (if employed) and into the exhaust line **105**. The cool exhaust can then be collected in any suitable arrangement to be compressed and returned to the tank **23** or used for any desired purpose including use as a working fluid in an air conditioning system or as a coolant for oil.

When using the apparatus and method of the present invention to adapt a ordinary internal combustion engine for operation with compressed gas it can be seen that considerable savings in weight are achieved. For example, the ordinary cooling system including a radiator, fan, hoses, etc. can be eliminated since the compressed gas is cooled as it expands in the cylinder. In addition, there are no explosions within the cylinder to generate heat. Further reductions in weight are obtained by employing plastic tubing for the lines which carry the compressed gas between the distributor and the cylinders and for the exhaust lines. Once again, heavy tubing is not required since there is little or no heat generated by the engine of the present invention. In addition, the noise generated by an engine according to the present invention is considerably less than that generated by an ordinary internal combustion engine since there are no explosions taking place within the cylinders.

The principles of preferred embodiments of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. The embodiments are to be regarded as illustrative rather than restrictive. Variations and changes may be made by others without departing from the spirit of the invention. Accordingly, it is expressly intended that all such variations and changes which fall within the spirit and the scope of the present invention as defined in the appended claims be embraced thereby.

What is claimed is:

1. An apparatus for operating an engine having at least one cylinder and a reciprocating piston therein comprising:

a source of compressed gas;

distributor means connected with the source of compressed gas for distributing the compressed gas to the at least one cylinder;

valve means for admitting the compressed gas to the at least one cylinder when the piston is in approximately a top dead center position within the cylinder;

altering means for increasing the duration of each engine cycle over which the valve means admits compressed gas to the at least one cylinder as the speed of the engine increases; and

exhaust means for exhausting gas as the piston subsequently approaches approximately the top dead center position.

2. The apparatus of claim 1 further comprising control means for controlling the amount of compressed gas admitted to the distributor means.

3. The apparatus of claim 1 wherein the valve means is a solenoid valve secured in an opening in the cylinder above the level of the piston at the top dead center position.

4. The apparatus of claims 1 or 2 further comprising means for advancing the timing of the valve means as the speed of the engine increases such that compressed gas is admitted progressively further before the top dead center position as the speed of the engine increases.

5. The apparatus of claim 4 wherein the means for advancing the timing comprises a mechanical linkage connected to an operator actuated accelerator linkage.

6. The apparatus of claim 1 wherein a portion of the gas exhausted through the exhaust means is compressed in a compressor driven by an output shaft of the engine and is returned to the source of compressed gas.

7. The apparatus of claim 1 wherein a portion of the gas exhausted through the exhaust means is used to cool transmission fluid for a transmission associated with the engine.

8. The apparatus of claim 1 wherein a portion of the gas exhausted through the exhaust means is used as a working fluid in an air conditioning system.

9. The apparatus of claim 6 further comprising first gearing means interposed between the output shaft of the engine and the compressor for increasing the speed at which the compressor is driven.

10. The apparatus of claim 6 further comprising clutch means attached to the compressor both for disengaging the compressor from the output shaft of the engine when a first predetermined pressure at the source of compressed gas is exceeded and for engaging the compressor with the output shaft of the engine when the pressure at the source of compressed gas drops below a second predetermined pressure.

11. The apparatus of claim 9 further comprising means for both disengaging the first gearing means when a predetermined speed of the engine is exceeded and engaging a second gearing means for driving the compressor at a speed slower than the first gearing means when the predetermined speed of the engine is exceeded.

12. The apparatus of claim 1 wherein the valve means is electrically actuated and wherein the altering means comprises:

a rotating member timed with the at least one cylinder and arranged within a housing;

first and second contacts arranged on a first end of the rotating member and on an inside surface of the housing, respectively;

means for increasing the distance of the first contact from the rotational axis of the rotating member as the speed of the engine increases such that the first contact moves radially outwardly within the housing; and

said second contact presenting a longer arc length to the first contact as the distance of the first contact from the rotational axis of the rotating member increases.

13. The apparatus of claim 12 wherein the rotating member comprises an arcuate arm and wherein the means for increasing the distance of the first contact comprises pivotally mounting a second end of the arcuate arm about the axis of rotation of the rotating member and spring means for biasing the first end of the arcuate arm towards a radially inward position whereby the first end of the arcuate arm pivots radially outwardly as the speed of the engine increases.

14. The apparatus of claim 12 wherein the rotating member is axially slidably received on a rotating shaft for co-rotation therewith, said shaft having splines with a radial component in the direction of rotation, and wherein the first contact comprises a flexible contact located on an upper surface of the rotating member, said flexible contact being biased against the inside surface of the housing which carries the second contacts whereby as the speed of the engine increases the rotating member is urged axially along the splined shaft towards the inside surface of the housing such that the flexible contact is forced radially outwardly along the inside surface.

15. The apparatus of claim 12 wherein the second contact comprises of radially extending conductor arranged on an upper inside surface of the housing, said conductor increasing in arc length as the conductor extends radially outwardly from a central portion of the housing.

16. An apparatus for adapting an internal combustion engine for operation with compressed gas, the internal combustion engine having at least one cylinder, a piston reciprocable within the at least one cylinder, intake and exhaust means disposed in the at least one cylinder, and a tapped hole in the at least one cylinder adapted to receive a spark plug, the apparatus comprising:

a source of compressed gas;

distributor means connected with the source of compressed gas for distributing the compressed gas to the at least one cylinder;

valve means arranged in the tapped hole for admitting the compressed gas to the at least one cylinder when the piston is in approximately a top dead center position within the cylinder; and

altering means for increasing the duration of each engine cycle over which the valve means remains open to admit the compressed gas as the speed of the engine increases.

17. An apparatus as in claim 16 further comprising first adapter plate means for supporting the distributor means above an intake manifold of the engine, which adaptor plate means allows ambient air to enter through the intake manifold.

18. The apparatus of claim 16 further comprising second adapter plate means for reducing the exit area of the exhaust means.

19. A method of operating an engine on compressed gas, said engine having at least one cylinder and a piston reciprocable therein comprising the steps of:

delivering compressed gas from a source to a distributor;

distributing the compressed gas to the at least one cylinder:

admitting compressed gas to the at least one cylinder through an intake valve when the piston is at approximately a top dad center position;

increasing the duration of each engine cycle over which compressed gas is admitted to the at least one cylinder as the engine speed increases; and

exhausting the remaining gas when the piston subsequently reaches approximately the top dead center position.

20. The method of claim **19** further comprising the step of controlling the amount of compressed gas which is delivered to the distributor.

21. The method of claim **19** further comprising the step of advancing the timing of the opening of the intake valve as the speed of the engine increases.

22. An apparatus for operating an engine having at least one cylinder and a piston reciprocable therein on compressed gas comprising:

a source of compressed gas;

distributor means connected with the source of compressed gas for distributing the compressed gas to the at least one cylinder;

electrically actuated valve means secured in an opening in the at least one cylinder for selectively admitting compressed gas to the at least one cylinder when the piston is in approximately a top dead center position; and

means for advancing the timing of the valve means as the speed of the engine increases whereby compressed gas is admitted progressively further before the top dead center position as the speed of the engine increases.

* * * * *

One of our correspondents says that Lee Rogers has also converted the diesel engine in a large farm tractor to run on air.

Rogers isn't giving out his design secrets to the public. He hasn't responded to my letters but what I hear is that he is planning to wait till the crisis hits before he makes his air car plans available in their complete form.

Rogers rumors updates:

1) The air car runs out of air at low speeds, but is self-fueling above 25-30 mph?

2) The high pressure air pulse goes to the cylinder, not as part of the power stroke as the patent states, but before the compression stroke?

The purpose is to refrigerate the air so that compression heat tends to stay in the syste

United States Patent [19]

Rogers, Sr.

[11] **Patent Number: 4,693,669**

[45] **Date of Patent: Sep. 15, 1987**

[54] **SUPERCHARGER FOR AUTOMOBILE ENGINES**

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[52] **U.S. Cl.** .... **415/143**; 415/199.6; 415/140; 415/219 C

[58] **Field of Search** .... 415/131, 132, 140, 142, 415/143, 198.1, 199.1, 199.4, 199.6, 207, 219 C

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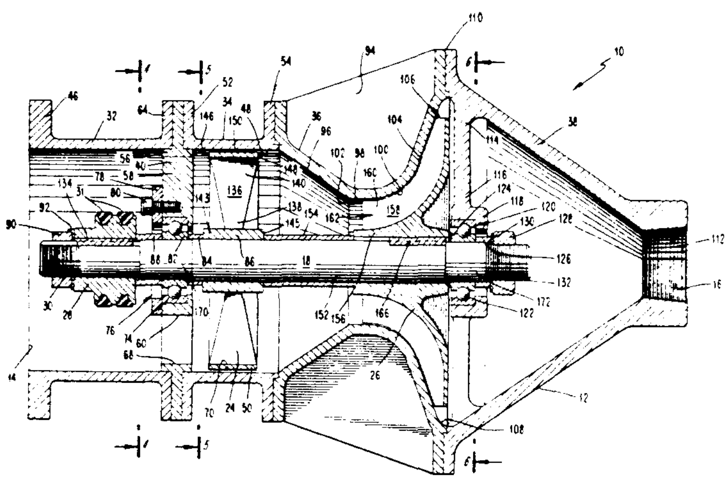
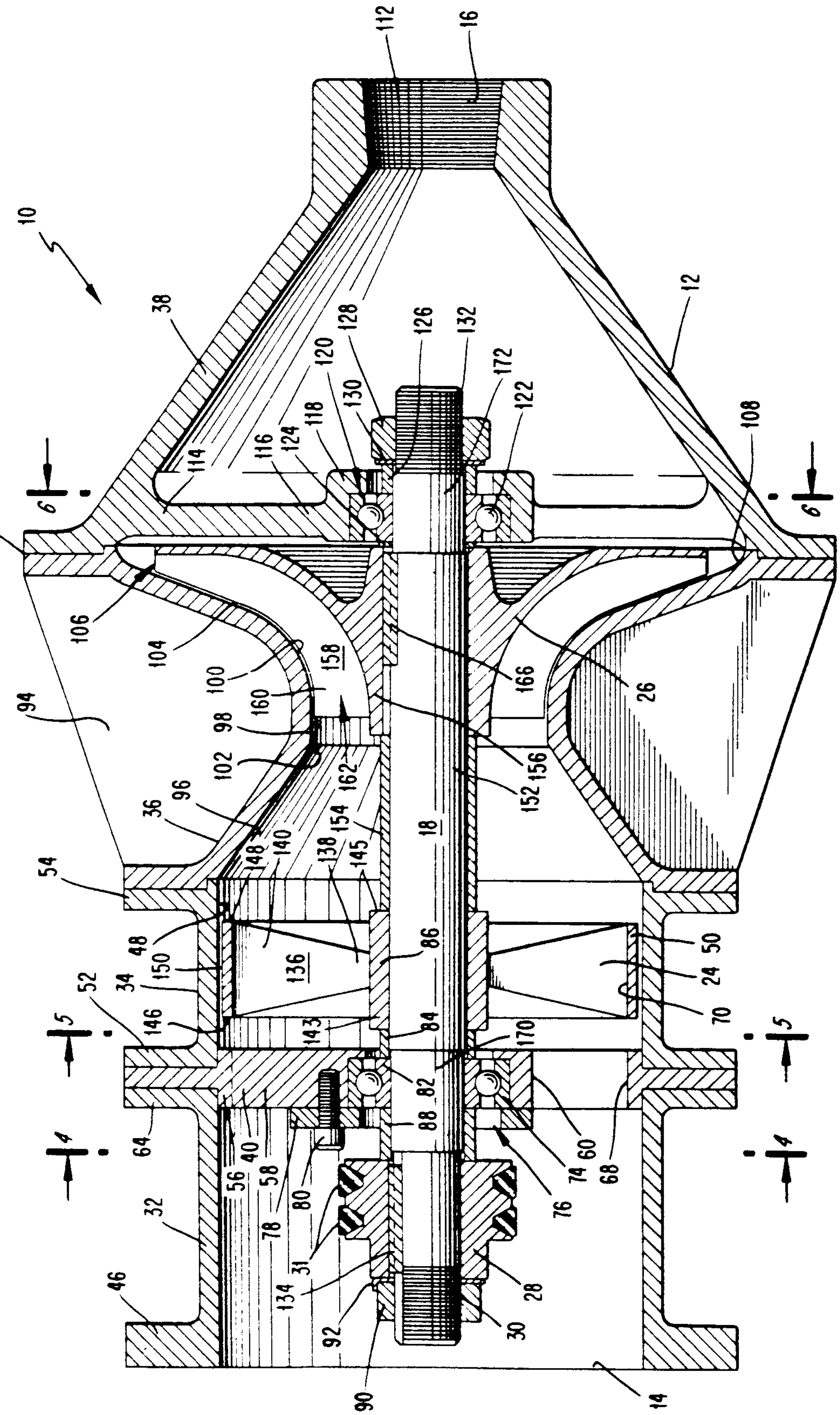
[57] **ABSTRACT**

A supercharger for delivering supercharged air to an engine, comprising a shrouded axial compressor, a radial compressor which is located downstream of the axial compressor and a housing. The housing comprising four sections, including a section defining a highly convergent, frustoconical transition duct which favorably directs the discharge of the axial compressor to the inlet of the radial compressor and a hollow, highly convergent, exhaust cone section immediately downstream of the radial compressor which converges into the exhaust port of the supercharger. An annular flow deflector is provided for directing the discharge of the radial compressor into the exhaust cone.

7 Claims, 8 Drawing Figures

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148
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152
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166
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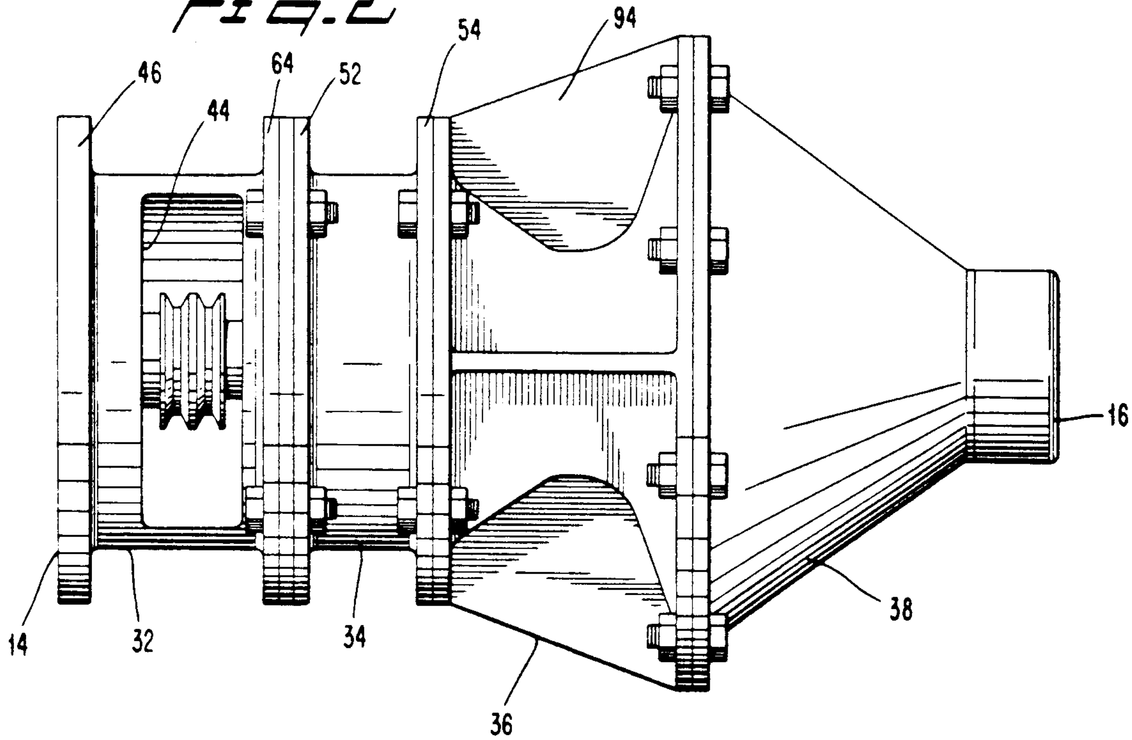
6

FIG. 1

Fig. 2



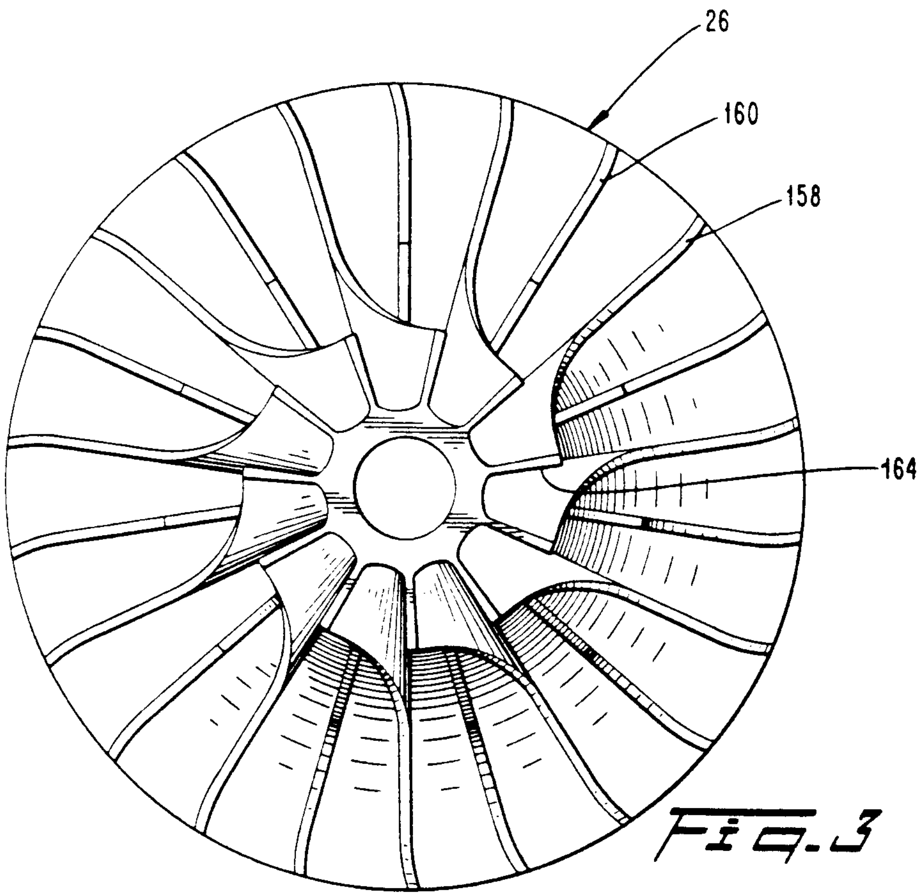
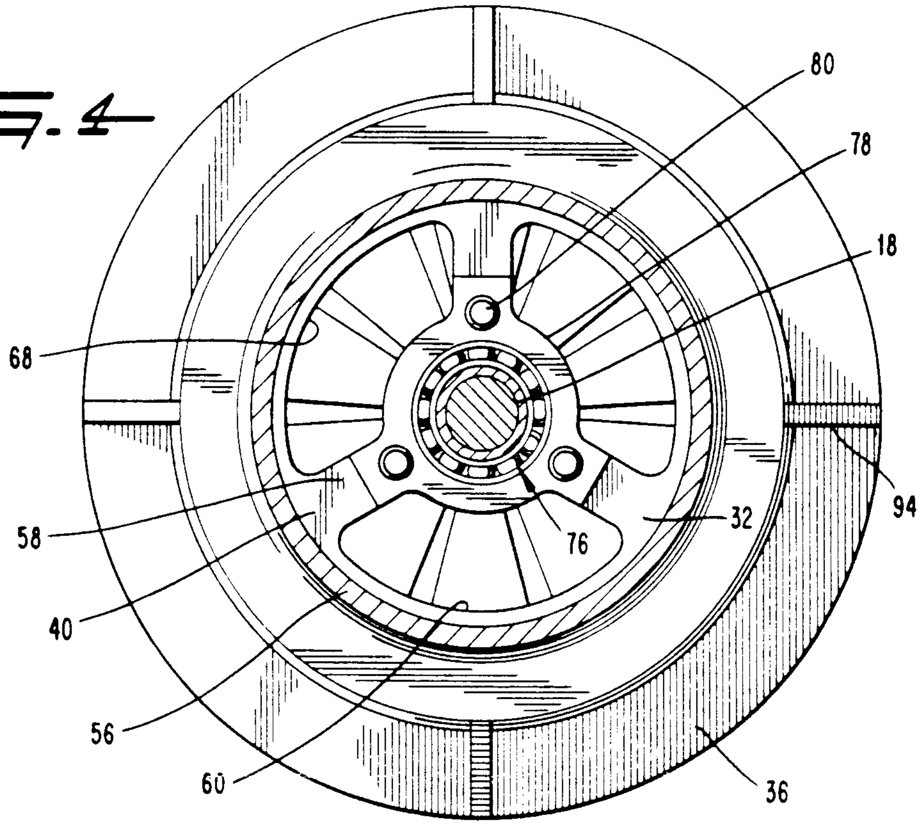


Fig. 3

Fig. 4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78
18
68
94
58
32
76
40
56
60
36

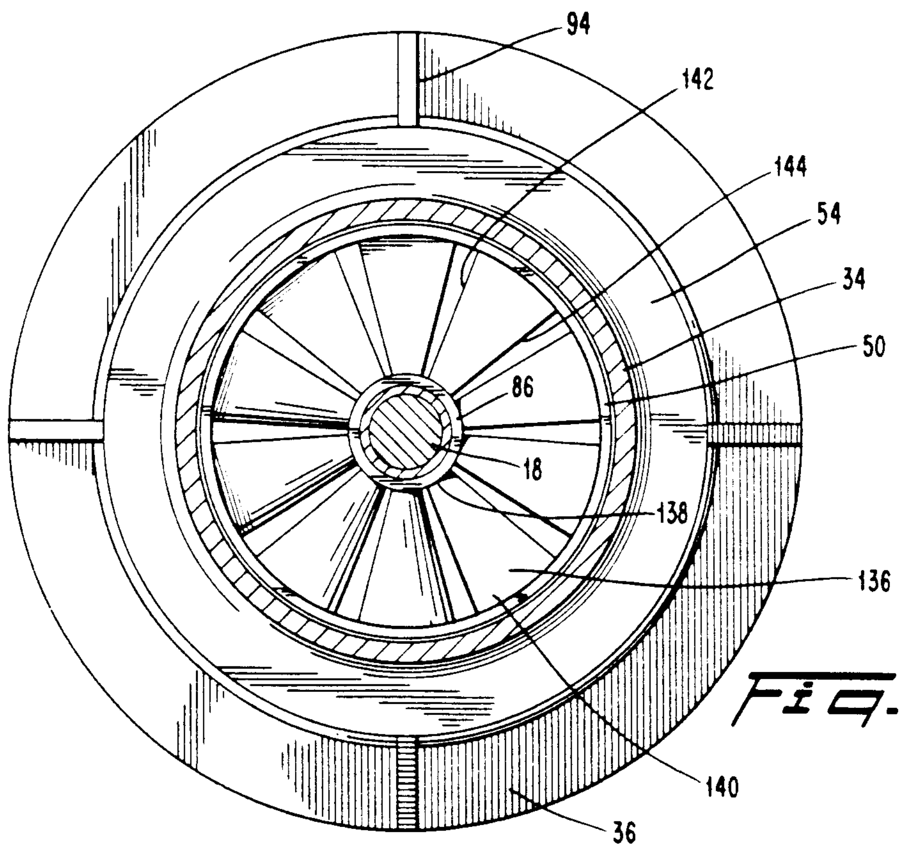

94
142
144
54
34
50
86
18
138
136
140
36

Fig. 5

Fig. 6

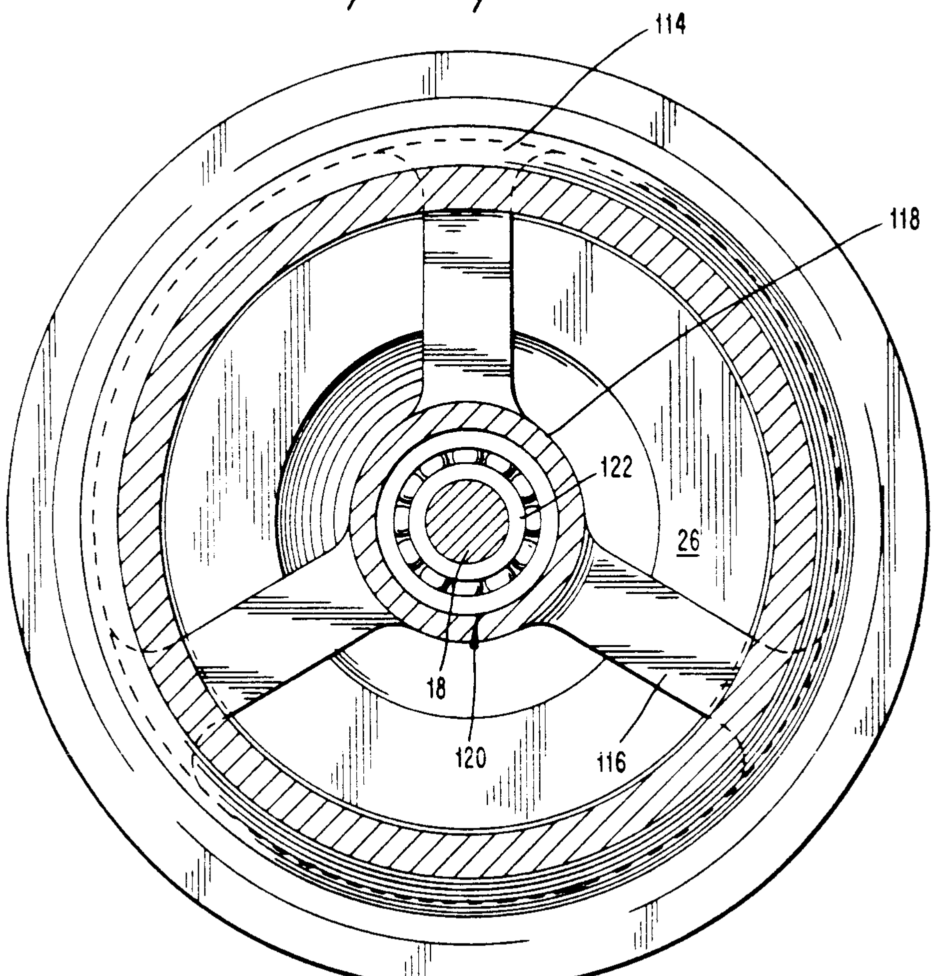


Fig. 7

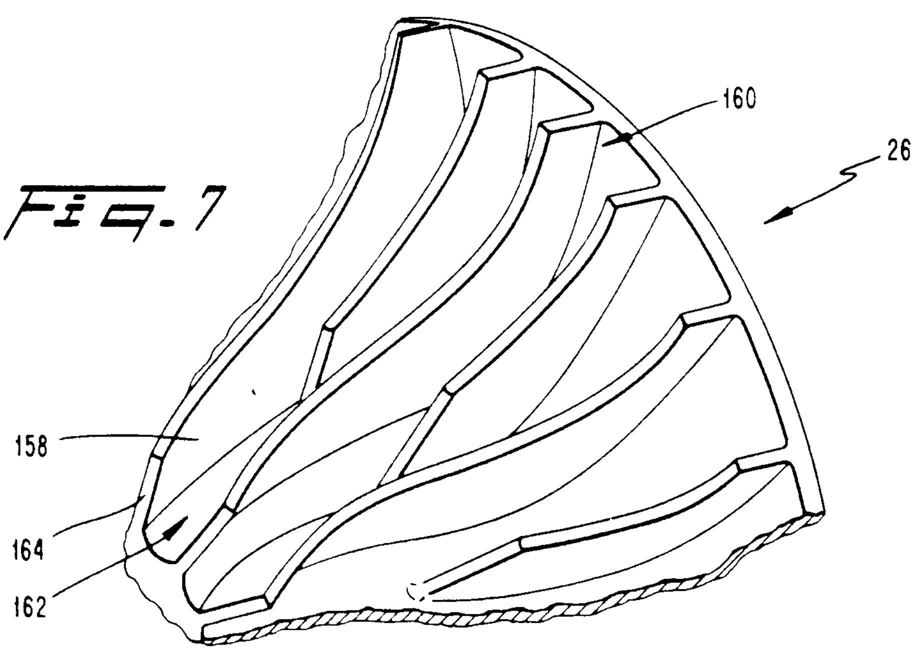
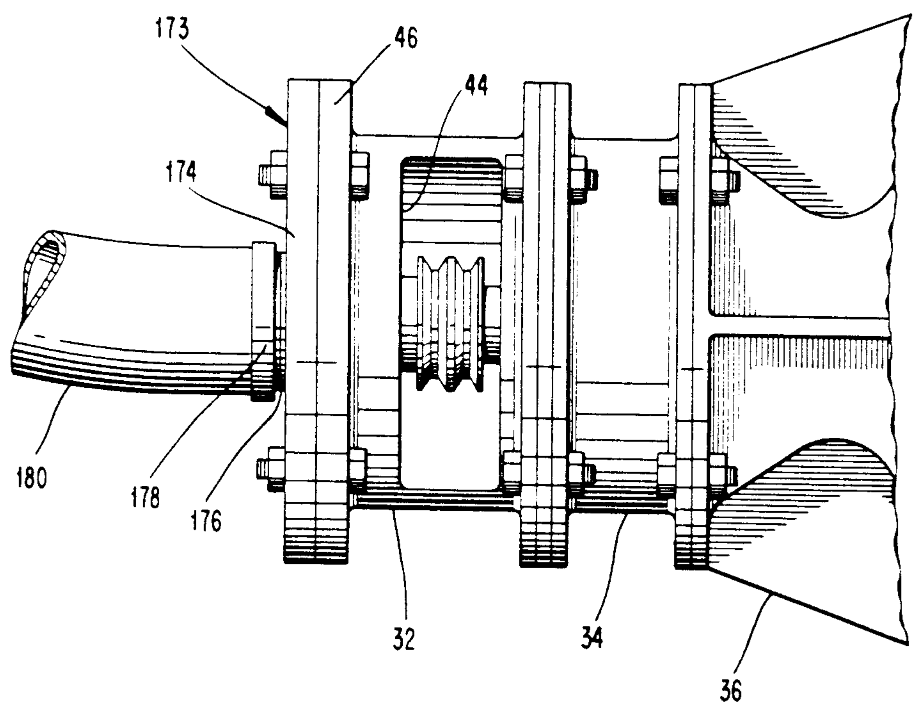


Fig. 8



SUPERCHARGER FOR AUTOMOBILE ENGINES

FIELD OF THE INVENTION

The present invention relates to superchargers generally and more particularly to superchargers for automotive engines which include both an axial stage compressor and a centrifugal stage compressor.

BACKGROUND OF THE INVENTION

Superchargers impart additional pressure to the air or the air/fuel mixture of an engine so that the cylinders receive a greater weight per unit volume of air or air/fuel mixture than would otherwise be supplied. As a result, the volumetric efficiency and power output of the engine are improved.

According to prior practices, superchargers generally comprise a single airblower which forces air on an air/fuel mixture into the cylinders of an engine. Typically, the airblower is driven by a gear train which is connected to the crankshaft of the engine with a gear ratio of about 6 to 1. These prior types of superchargers have been used extensively in racing engines and radial aircraft engines. However, by reason of their high operating speeds and their gear trains, these superchargers have been considered too complicated, too heavy and too costly for use with mass production engines such as are found in automobiles and trucks.

Recently, some automobile manufacturers have been offering turbocharged engines which expand to exhaust gases of the engine through a turbine to drive a centrifugal compressor. Although turbochargers are advantageous in that the turbine can deliver large amounts of power to the compressor, their extreme operating speeds require special bearings, lubrication and maintenance. In addition, turbochargers require special ducting, such as by-pass arrangements, which only add to their cost and maintenance requirements. Consequently, turbochargers are only offered as expensive options in automobiles.

Further, there is current interest in a new type of automobile engine which operates from tanks of compressed gas to effect reciprocation of its pistons. An example of such an engine can be found in the U.S. Pat. No. 4,292,804 issued to the same inventor of the present invention. In the referenced patent, at least a portion of the partially expanded exhaust gas from the cylinders is directed to a compressor where it is recompressed and then returned to the storage tanks from whence it originally came. It would be desirable that at least some, if not all of the aforementioned recompression of the exhaust gas could be achieved with a belt-driven, rotary supercharger that is easily manufactured and maintained, yet is capable of providing ample recompression.

OBJECTS OF THE INVENTION

Accordingly, an object of the present invention is to provide a supercharger suitable for improving the performance of engines of automobiles, helicoptors or the like, which supercharger is inexpensive to produce and easy to maintain.

It is another object of the present invention to provide a supercharger which provides sufficient boost without resort to extreme operating speeds and accordingly avoids the costly complications associated with high speed operation.

It is yet another object of the present invention to provide a relatively compact and lightweight supercharger which is inexpensive to manufacture and maintain.

Another object of the present invention is to provide a belt-driven supercharger having a design which provides supercharging compression at relatively low operating speeds.

It is still another object of the present invention to provide a supercharger which can be quite readily disassembled and reassembled for purposes of low cost maintenance and repair.

Still another object of the present invention is to provide a supercharger which can be constructed from mass productible parts to thereby reduce the cost of its manufacture.

It is still another object of the present invention to provide a belt-driven supercharger which provides supercharging compression without resort to a larger number of compressor stages.

Yet another object of the present invention is to provide a rotary supercharger for a gas operated engine, which supercharger is easily manufactured and maintained, yet capable of providing ample recompression of the recirculating drive fluid.

SUMMARY OF THE INVENTION

These and other objects are achieved by the present invention which provides a supercharger comprising a housing having an inlet and an outlet, a shrouded axial compressor and a radial compressor rotatably mounted within the housing, a highly convergent shallow, frustoconical transition duct for favorably directing the discharge of the axial compressor to the inlet of the radial compressor.

In accordance with a further aspect of the invention, the above-described supercharger further comprises an exhaust cone at a location downstream of the radial compressor and a flow deflector for directing the discharge of the radial compressor to the exhaust cone.

In the preferred embodiment, the housing itself comprises four sections: a cylindrical front housing section which defines an axially directed inlet; a second, cylindrical ducting section enclosing the axial compressor; a rear housing section defining the transition duct as well as the inlet and casing for the radial compressor; and the exhaust cone section which defines at its terminis the outlet of the housing. For driving the compressor shaft, a double-tracked pulley wheel is secured to the forward end of the common shaft, which pulley wheel is adapted to receive one or more drive belts from the crank-shaft wheel of the engine. A lateral opening in the front housing section accommodates the connection with the drive belts.

With the disclosed arrangement, compression can be achieved for supercharging purposes without resort to a large number of compressor stages or high operating speeds. Additionally, the design of the disclosed supercharger avoids the need for guide vanes between the axial compressor and the radial compressor. The exhaust cone section also favorably avoids the build-up of back pressure against the radial compressor. The design is also very simple and therefore inexpensive to manufacture and maintain.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention is described in greater detail with reference to the accompanying drawing wherein like elements bear like reference numerals, and wherein:

FIG. **1** is a cross-sectional side view of a supercharger constructed in accordance with the preferred embodiment of the present invention;

FIG. **2** is a side view of the supercharger of FIG. **1**;

FIG. **3** is a frontal view of the impeller of the supercharger of FIG. **1**;

FIG. **4** is a cross-sectional view taken along line **4**—**4** of FIG. **1**;

FIG. **5** is a cross-sectional view taken along line **5**—**5** in FIG. **1**;

FIG. **6** is a cross-sectional view taken along line **6**—**6** in FIG. **1**;

FIG. **7** is a perspective view of a segment of the impeller of the supercharger of FIG. **1**; and

FIG. **8** is a partial side view of the supercharger of FIG. **1** with an adaptor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, a supercharger **10** is provided for supplying supercharged air to an automobile engine or the like, so that the engine receives a greater weight per unit volume of air or a fuel/air mixture than would be otherwise supplied. In accordance with a preferred embodiment of the present invention, the supercharger **10** comprises a housing **12** having an axially directed inlet **14** for receiving ambient air and an axially directed outlet **16** for delivering supercharged air to the intake of the automobile engine. Rotatably mounted within the housing **12** is a shaft **18** on which are secured an axial compressor **24** and a radial compressor **26**, the radial compressor **26** being positioned downstream of the axial compressor **24**. A pulley wheel **28** is secured to a forward end **30** of the shaft for receiving drive belts **31**, which belts drivingly connect the shaft **18** to a pulley wheel on the crankshaft of the engine (not shown). The drive belts **31** deliver torque to the shaft **18** as required for driving the compressors **24** and **26** of the supercharger **10**.

The housing **12** itself is constructed from four sections which are preferably bolted together at flanged connections in end-to-end relationship. These sections include a front housing section **32**, an axial compressor duct section **34**, a rear housing section **36** and an exhaust cone section **38**. The shaft **18** extends along the longitudinal axis of the housing **12**.

The front housing section **32** is a hollow cylinder which extends forward of a front bearing support **40**. The front housing section **32** encloses the forward end **30** of the shaft **18** and the associated pulley wheel **28**. At its forward end, the front housing section **32** defines the inlet **14** for receiving air from an external source (not shown). Referring particularly to FIG. **2**, the front housing section **32** includes a lateral opening **44** on one side in order to accommodate the connection of the drive belts **31** to the pulley wheel **28**. The front housing section **32** also includes a forward flange **46** for accommodating the connection of air filters, carburetors, air scoops or the like upstream of the supercharger **10** according to the particular engine layout.

It is to be understood that in the usual engine layout, the supercharger **10** receives air or a fuel/air mixture from an external source through its inlet **14**, compresses the air or fuel/air mixture and then delivers it to the intake of the engine.

Referring again to FIG. **1**, the pulley wheel **28** is interference-fitted upon the forward end **30** of shaft **18** and a key **134** is used to lock the pulley wheel **28** in place. The pulley wheel **28** is preferably a double-track design which is suitable for the attachment of twin drive belts, although a single-belt type pulley wheel would be adequate. The pulley wheel **28** is preferably sized such that the ratio of its diameter with respect to the diameter of the drive wheel of the engine's crankshaft provides an effective gearing ratio in the range of approximately two and one-half to four and one-half. Thusly at idle, when the automobile engine is running approximately 700 rpm, the supercharge **10** is running at approximately 2,400 rpm, and at cruise, when the engine is running in the range of 2,500, the supercharger **10** is preferably turning over in the range of 6,000 to 8,000 rpm. It is to be noted that although the diameter of the pulley wheel **28** may be substantially reduced in order to achieve a desired gearing ratio, the double-track wheel **28** presents a sufficient sum total of surface area to avoid slippage of the belts **31**.

The next adjacent section of housing **12** is the axial compressor duct **34** comprising a short cylinder which is coaxially disposed about the axial compressor **24**. Preferably, the axial compressor duct **34** is constructed from cast aluminum, with the interior surfaces **48** machined to assure uniform clearance between the duct **34** and a shroud **50** of the axial compressor **24**. As with other sections of the housing **12**, the axial compressor duct **34** is provided with flanges **52** and **54** for effecting connection to the adjacent housing sections. The axial compressor duct **34** guides air delivered from the front housing section **32** toward the axial compressor **24**.

Referring now to FIGS. **1** and **4**, a front bearing support **40** is interposed between the front housing section **32** and the axial compressor duct **34**. The front bearing support **40** includes an outer annulus **56** and three radially directed arms **58** between which arms are defined passages **60** for allowing air to pass through the bearing support **40**. The outer annulus **54** is secured by bolts connecting a rear flange **64** of the front housing section 32 and the flange **52** of the axial compressor duct **34**. By such arrangement, the front bearing support **40** is rigidly secured to the housing **12** such that loads and shocks to the shaft **18** can be transferred through the front bearing support **40** to the housing **12**.

In the preferred embodiment, the outer annulus **56** of the bearing support **40** extends into the region of the inlet **14** of the front housing section **32** such that its inner rim **68** coincides with the inner rim **70** of the shroud **50** of the axial compressor **24**. In this fashion the outer annulus **56** contributes to the guiding of the flow of air toward the axial compressor **24**.

An outer raceway **74** of the front roller bearing assembly **76** is secured between the front bearing support **40** and a bearing retainer plate **78**, which plate **78** is secured by removable bolts **80**. In the preferred embodiment, the front bearing assembly **76** is of the sealed, high speed type. A suitable commercially available bearing assembly is marketed under model Fafnir 405KDD. A lower raceway **82** of the front bearing assembly **76** is preferably secured to the shaft **18** with an interference fit. A spacer **84** is provided on one side of the lower raceway **82**, which spacer **84** also abuts a hub **86** of the axial compressor **24** to thereby place the axial compres-

sor 24 a predetermined distance downstream of the bearing support 40. Similarly, a spacer 88 is provided on the other side of the lower raceway 84, which spacer 88 also abuts the pulley wheel 28 so as to space apart the pulley wheel 28 from the front bearing support 40 to assure sufficient clearance between same.

It is to be appreciated that the bearing retainer plate 78 allows ready access to the front bearing assembly 76 for purposes of maintenance or repair. To service the front bearing assembly 76, a nut 90 and lock-washer 92 on the forward end 30 of the shaft 18 are loosened and removed together with the pulley wheel 28 and the spacer 88. Then bolts 42 and the bearing retainer plate 76 are removed, leaving the whole bearing assembly 76 exposed for servicing and/or removal.

The rear housing section 36 is connected by bolts to the downstream end of the axial compressor duct 34. Preferably, the rear housing section 36 is constructed from a single section of cast aluminum and includes external longitudinal ribs 94 for enhancing the structural rigidity of the rear housing section 34. The walls of the rear housing section 36 define three elements of the supercharger 10: a highly conical transition duct 96 which favorably directs the output of the axial compressor to an inlet 98 of the radial compressor 26; the inlet 98 of the radial compressor 26, itself; and a casing 100 for the radial compressor 26.

The transition duct 96 is a hollow, frustoconical portion having a half-apex angle (from the generatrix to the axis of symmetry) of approximately 35°. The angle is selected such that the inlet to the radial compressor 26 is as close as possible to the outlet of the axial compressor 24 without causing undue back-pressure. In the preferred embodiment, the transition duct 96 begins a short distance downstream of the axial compressor 24 and ends at the beginning of the inlet 98 of the radial compressor 26. The highly conical shape of the transition duct 96 is believed to roll-in the higher volume of air being discharged from the more radially outward portions of the axial compressor 24. This rolling-in action is believed to promote a favorable flow regime at the inlet 98 of the radial compressor 26 such that the need for inlet guide vanes for the radial compressor 26 is avoided. It is also believed that the highly conical shape of the transition duct 96 affects upstream flow conditions at the axial compressor 24 such that its performance is improved. It has also been found that the need for a stator (or exit guide vane) for the axial compressor 24 is likewise avoided.

In essence, it is believed that the transition duct 96 performs the functions of the aforementioned exit vanes of axial compressors and inlet guide vanes of radial compressors, but without the pressure losses commonly associated with them. Because of the avoidance of these pressure losses and by reason of the expected improvement in the performance of the axial compressor, the supercharger 10 is able to impart a higher overall pressure ratio than would otherwise be achieved without the transition duct 96. As a result, adequate compression is achieved at moderate operating speeds without resort to a bank of several axial compressors. It is to be understood, however, that when connecting the supercharger 10 to a relatively slowly reciprating diesel or a very large engine, it may be desirable to include two or more axial compressors in order to boost the supercharger's overall pressure ratio. In such case, practice of the present invention would include the placement of a transition duct as above described downstream of at least the last axial compressor.

At the inlet 98 of the radial compressor 26, the walls of the rear housing 36 are cylindrical and coaxially disposed about the shaft 18. It is to be noted that in the preferred embodiment, the surface transition 102 from the transition duct 96 to the inlet 98 is rounded-off.

The casing portion 100 of the rear housing section 36 closely follows the contour defined by blade edges 104 of the radial compressor 26 in a close, substantially sealing manner as is well known in the art of radial compressors. The casing portion 100 of the rear housing section 78 channels air between the rotating blades of the radial compressor 26 so that the blades can impart work to the passing air. The casing portion 100 also defines a discharge outlet 106 for the radial compressor 26.

Just beyond the discharge outlet 106 of the radial compressor 26, the interior surfaces of the rear housing section 36 begin to curve immediately inwardly to provide a transition into the next adjacent section of the housing 12, the exhaust cone 38. In this fashion, the interior surfaces at the rear-most portion of rear housing section 36 and those of the forward portion of the exhaust cone 92 define internally a flow deflector 108. In the preferred embodiment, the flow deflector 108 is closely and concentrically disposed about the outlet 106 of the radial compressor 26 such that the air being discharged from the radial compressor 26 does not have the opportunity to diffuse significantly prior to its arrival at the annular flow deflector 108. The annular flow deflector 108 directs the output of the radial compressor 26 into the exhaust cone 38 by providing a smooth surface transition from the interior of rear housing section 36 to the interior of the exhaust cone 38.

The exhaust cone 38 is a highly convergent, hollow, frustoconical section placed immediately downstream of the radial compressor 26 for receiving the output of the radial compressor 26 from the annular flow deflector 108. In the preferred embodiment, the exhaust cone 38 is a single section of cast aluminum which is joined to the downstream end of the rear housing section 36 at a flanged joint 110. Preferably, the exhaust cone 92 converges according to a half-apex angle of approximately 35° and defines the exhaust port 16 at its terminus. Threading 112 at the exhaust port 16 accommodates the attachment of the appropriate external ducting (not shown) leading to the intake of the engine.

During operation of the supercharger 10, the space enclosed by the exhaust cone 92 prevents the build up of an elevated back pressure which might otherwise arise and detract from the operation and efficiency of the radial compressor 26. The enclosed space of the exhaust cone 92 is also of sufficient volume to absorb pulses and to average out unsteady flow conditions so to promote a smooth and continuous output from the supercharger 10.

Referring now to FIGS. 1 and 6, the exhaust cone 38 includes a rear bearing support 114 which comprises members 116 which extend radially inwardly from the outer walls of the exhaust cone 38. At a radial inward location close to the shaft 18, the members 116 converge to form a cupped annulus which serves as a housing 118 for the rear bearing assembly 120. The housing 118 is open towards the rear face of the radial compressor 24 to facilitate disassembly of the supercharger 10. The rear bearing assembly 120 is the same type and size as the front bearing assembly 76. The inner race 122 of

the bearing assembly **120** is set in place on the shaft **18** by spacers **124** and **126** in conjunction with a nut **128** and washer **130** on the rearward end **132** of the shaft **18**. In the preferred embodiment, the members **116** are integrally formed with the walls of the exhaust cone **38**.

Referring to FIGS. **1** and **5**, the axial compressor **24** upon rotation draws air through the inlet **14** and imparts an initial amount compression to the air as it forces the air into the transition duct **96** of the rear housing section **36**. In the preferred embodiment, the axial compressor **24** comprises a hub **86**, the shroud **50** and a series of ten (10) equally spaced, radially disposed blades **136**. Preferably, each blade **136** increases in cord from a root **138** to a tip **140** and includes a trailing edge **142** and a leading edge **144**, which edges are both slightly curved. The blades gradually increase in pitch from approximately 12° at the root **138** to approximately 36° at the tips **140**. However, the particular values of pitch and other geometrical aspects of the blades **136** might be varied in accordance with different operating speeds or other parameters as would be apparent to one skilled in the pertinent art and familiar with this disclosure.

The axial compressor **24** is preferably constructed from a single, cast aluminum section with the faces **143** and **145** of the hub **86** being machined for purposes of achieving accurate, axial positioning of the axial compressor **24** on the shaft **18** relative to the housing **12**. The faces **146** and **148** of the shroud **72** are also machined flat. Additionally, the outer periphery **150** of the shroud is machined to assure uniform clearance between the shroud and the adjacent interior surfaces **48** of the axial compressor duct **34**. The axial compressor **24** is preferably secured to the shaft **18** by an interference-fit onto a stepped portion **152** of the shaft **18**. The spacers **84** and **154** axially position the axial compressor **24** relative to the front bearing support **40** and the radial compressor **26**, respectively.

Dynamic balance test machines of the conventional type may be used to test the balance of the axial compressor **24** prior to its installation. If an imbalance is detected, material can be removed at the outer periphery **150** of the shroud **50** so as to achieve proper balance.

Referring now to FIGS. **1**, **3**, and **7**, the radial compressor **26** is constructed from a single section of cast aluminum and includes a hub **156** and curved blades **158**. Interposed between each pair of blades **158** are a second set of blades **160** which terminate short of the intake **162** of the radial compressor **26** so that the intake **162** is not crowded by both sets of blades. Accordingly, the radial compressor **26** features both a large total number of blades and an intake of relatively small diameter, which features enhance the performance of the compressor **26**. In the region of the intake **162**, the blades **158** present leading edges **164** and undergo a twist into the direction of rotation so as to prevent a favorable angle of attack at the intake **162**.

Preferably, the radial compressor **26** is positioned upon the stepped section **128** of the shaft **18** with an interference-fit and locked against rotational slippage by a key **166**. The spacer **124** assures clearance between the rear face of the radial compressor **26** and the rear bearing assembly **120**.

The shaft **18** is constructed from a hardened steel and is threaded at both ends **30** and **132** for receiving nuts **90** and **128**, respectively. In addition to the central stepped portion **152**, which receives the compressors **24** and **26**, the shaft **18** also features stepped portions **170** and **172** for receiving the front and rear bearing assemblies **76** and **120**, respectively. The stepped arrangement of the shaft **18** facilitates assembly and disassembly in that the stepped portion **152** of the greatest diameter is centrally located on the shaft **18** and all the stepped portions are greater than the diameter of the threading at ends **30** and **132**.

It is to be noted that the bearing supports **40** and **114** are in a fixed position relative to the housing **12** and that the compressors **24** and **26** are positioned between the bearing supports **22** and **40** by spacers **84**, **124** and **154**, which spacers have predetermined lengths. Consequently, the placement of the compressors **24** and **26** relative to the longitudinal axis of the housing **12** is fixed by the aforementioned spacers and not by the axial location of the shaft **18** relative to the housing **12**. It is also to be noted that the stepped portions **152**, **170** and **172** of the shaft **18** are each provided with extra lengths such that the respective components (the bearing assemblies and compressors) can each be situated over a relatively wide range of situses in the respective stepped portions. Thusly, the shaft **18** need not be accurately positioned along the longitudinal axis of the housing **12** in order to achieve proper assembly of the supercharger **10**. For instance, if nuts **90** and **128** had been tightened differently than as they appear in FIG. **1**, the shaft **18** might have been displaced slightly in the axial direction from where it is shown in FIG. **1**. However, the relative positioning of the various components on the shaft **18**, i.e., the pulley wheel **28**, the compressors **24** and **26** and the bearing assemblies **76** and **120**, would have remained the same relative to themselves and the housing **12**. This feature eases the process of manufacture and accordingly, reduces the costs of same. It also reduces the amount of labor required for reassembly after repair.

In operation, the supercharger **10** is suitably connected at its outlet **16** to an intake of an automobile engine, with the drive belts **31** from the crankshaft of the engine being attached to the pulley wheel **28** of the supercharger **10**. Then, as the engine is operated, torque is transferred by the drive belts **31** to the pulley wheel **28** for driving the compressors **24** and **26**. Upon rotation, the axial compressor **24** draws air through the inlet **14**, imparts an initial amount of compression to the air and discharges it into the transition duct **96** with a swirl. By reason of its design, the axial compressor **24** is believed to move a greater volume of air in the region of its blade tips **140** than at its more radially inward locations. Accordingly, there is a greater of mass of air situated at the outer annular region behind the axial compressor **24** than at the inner annular region. As the discharge from the axial compressor **24** is caused to leave the axial compressor duct **34**, the highly convergent, transition duct **96** is believed to cause the outer annulus of air which is discharged from the axial compressor **24** to roll-in. This action is believed to have two favorable results. First, the roll-in action causes a flow regime to be established at the inlet **98** of the radial compressor **26** such that the need for a guide vane is wholly avoided. Secondly, and of equal importance, the rolling-in action, in conjunction with the large volume of space enclosed by the transition duct **96**, is believed to favorably effect the performance of the axial compressor **24** such that a higher pressure ratio is obtained therefrom.

Since the overall pressure ratio of the supercharger **10** is the product of the pressure ratios of the two compressors, it can be seen that the aforementioned increase in performance of the axial compressor **24** results in a

corresponding improvement in overall performance of the supercharger **10**. It is also to be noted that the deletion of inlet guide vanes for the radial compressor **26** and of exit vanes for the axial compressor **24** greatly simplifies the design of the rear housing section **36** and therefore provides savings in costs of manufacture. It also avoids the pressure losses associated with such guide vanes, which are often quite significant.

Upon leaving the transition duct **96**, the pre-swirled flow of air enters the inlet **98** of the radial compressor **26** and then into the compressor **26** itself. In passing through the radial compressor **26**, the air is turned and whirled such that the airflow is centrifugally discharged with a substantial radial velocity component, whereupon the resultant flow is abruptly turned by the annular flow deflector **108** and caused to enter the exhaust cone **38**. As previously explained, the large volume of space enclosed by the exhaust cone **38** induces flow conditions behind the radial compressor **26** such that elevated back pressures are avoided which might otherwise impair the performance of the radial compressor **26**. Pulses in the output of the radial compressor **26** are also moderated. The air is then delivered in a compressed state to the exhaust port **16** of the exhaust cone **38**. The supercharged air then flows down the appropriate intake system of the engine until it reaches the cylinder or cylinders of the engine.

With respect to the application of the supercharger **10** to air-tank powered engines, such as disclosed in U.S. Pat. No. 4,292,804, the supercharger **10** functions in the same manner as described above, but is connected to the engine differently. In the air tank powered engine, at least one of the exhaust manifolds of the engines delivers partially expanded air to a line connected to the inlet **14** of the supercharger **10**. Referring to FIG. **8**, in most of such applications, this line will be of a smaller diameter than the housing **12** at the inlet **14** of the supercharger **10**, such that an adaptor **173** is needed. The adaptor **173** comprises an annular plate **174** having a threaded aperture **176** sized to receive a mating, threaded end **178** of the aforementioned line **180**. The plate **174** is secured the flange **36** of the front housing section **32** by a plurality of bolts. Because the air coming from the line **180** is usually less than the full capacity of the supercharger, additional air is introduced through the lateral opening **44** along the side of the front housing section **32**. In this application, the opening **44** thusly serves as an air intake port as well as a means for accommodating the drive belts **31** and must therefore be sized upon the additional criteria that it not be so large as to upset the flow of the incoming air in the line **180**. Upon the passage of the air through the supercharger, the air is directed through the exhaust port **16** and into a suitable line connected thereto, which line may lead directly to the engine or to the storage tanks of the engine. If directed to the tanks, this recompressed air is utilized to supplement the required recharging of the storage tanks.

It is to be appreciated that savings in the cost of manufacturing the supercharger **10** are achieved by reason that the housing **12**, the bearing supports **40** and **114**, the axial compressor **24** and the radial compressor **26** are all constructed from cast aluminum parts and require only a minimum amount of machining. Moreover, the roller bearing assemblies **76** and **120** are commercially available components, and the supercharger **10** is easily assembled. These aspects further reduce the cost of manufacture and render the disclosed supercharger inexpensive to maintain and overhaul. More importantly, the supercharger **10**, despite its simple design, provides supercharging at relatively low operating speeds. With its lower operating speeds, the service life of the supercharger **10** is extended and the risk of it suffering mechanical failure is reduced. The need for special bearing designs and lubrication is also avoided. Accordingly, the supercharger **10** is highly suitable for mass production and for use in automobiles, trucks, helicoptors or the like.

It is to be understood that the present invention may be embodied in other specific forms without departing from the spirit or essential characteristics of the present invention. The preferred embodiments are therefore to be considered illustrative and not restrictive. The scope of the invention is set forth in the appended claims rather than by the foregoing descriptions and all changes or variations which fall within the meaning and range of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A supercharger comprising:

a housing having a longitudinal axis and being constructed from sections, which sections are connected in end-to-end relationship with flanged joints, said sections including a front housing section defining an axially directed inlet, an axial compressor duct section for housing an axial compressor, a rear housing section downstream of said axial compressor duct section, and a hollow, highly convergent, frustoconical, exhaust cone section downstream of said rear housing section, a downstream portion of said rear housing section defining a cylindrical, axially directed inlet for a radial compressor, a casing for a radial compressor, and a substantially radially directed outlet for a radial compressor, said rear housing section further defining a highly convergent, hollow, frustoconical transition duct between a downstream end of said axial compressor duct section and said radial compressor inlet, said rear housing section having interior surfaces for defining a flow deflector, which flow deflector receives the output of said outlet for a radial compressor, which flow deflector provides a smooth surface transition from said rear housing section into said exhaust cone section, said exhaust cone section defining at a downstream end a coaxial outlet, said housing further including at least two bearing supports affixable within said housing according to predetermined locations along said longitudinal axis of the housing, said bearing mounts rotatably supporting a compressor shaft, which compressor shaft is positioned along said longitudinal axis;

sealed bearing assemblies removably implaced in said bearing supports, said sealed bearing assemblies receiving said compressor shaft;

a shrouded axial compressor located within said axial compressor duct and secured to said shaft to be rotatable therewith, said shrouded axial compressor drawing a flow from said inlet of the front housing section and imparting an initial compression to said flow;

a radial compressor located within said casing and secured to said shaft to be rotatable therewith, said casing being in a substantially sealing relationship with said radial compressor, said radial compressor including a hub, a first set of blades extending radi-

ally from said hub and having leading edges at an intake region of said radial compressor and a second set of blades extending radially from said hub and having leading edges downstream of said intake region, said radial compressor further compressing said flow;

at least one pulley wheel secured to said compressor shaft and adapted to receive drive belts;

spacers fitted upon said compressor shaft for axially positioning said axial compressor and said radial compressor relative to each other and relative to said bearing supports; and

means for securing said compressor shaft against axial displacement;

wherein said transition duct favorably directs the output of the axial compressor into said inlet of the radial compressor and said exhaust cone section encloses sufficient volume to moderate the output of said radial compressor.

2. The supercharger as claimed in claim 1 wherein said transition duct section and said exhaust cone section each have a half-apex angle of approximately 35°.

3. A supercharger comprising:

a housing having a longitudinal axis and being constructed from sections, which sections are connected in end-to-end relationship, said sections including a front housing section defining an axially directed inlet, an axial compressor duct section for housing an axial compressor, a rear housing section downstream of said axial compressor duct section and an exhaust section having a hollow, highly convergent, frustoconical, exhaust cone portion downstream of said rear housing section, a downstream portion of said rear housing section defining a cylindrical, axially directed inlet for a radial compressor, a casing for a radial compressor, and a substantially radially directed outlet for a radial compressor, said rear housing section further defining a highly convergent, hollow, frustoconical transition duct between a downstream end of said axial compressor duct section and said radial compressor inlet, said rear housing section having interior surfaces for defining a flow deflector, which flow deflector receives the output of said outlet for a radial compressor, which flow deflector provides a smooth surface transition from said rear housing section into said exhaust section, said exhaust cone portion defining at a downstream end a coaxial outlet, said housing further including at least two bearing supports affixable within said

housing according to predetermined locations along said longitudinal axis of the housing, said bearing mounts rotatably supporting a compressor shaft, which compressor shaft is positioned along said longitudinal axis;

bearing assemblies removably implaced in said bearing supports, said bearing assemblies receiving said compressor shaft;

an axial compressor located within said axial compressor duct and secured to said shaft to be rotatable therewith, said axial compressor drawing a flow from said inlet of the front housing section and imparting an initial compression to said flow;

a radial compressor located within said casing and secured to said shaft to be rotatable therewith, said casing being in a substantially sealing relationship with said radial compressor, said radial compressor including a hub, a first set of blades extending radially from said hub and having leading edges at an intake region of said radial compressor and a second set of blades extending radially from said hub and having leading edges downstream of said intake region, said radial compressor further compressing said flow;

at least one pulley wheel secured to said compressor shaft and adapted to receive drive belts;

spacers fitted upon said compressor shaft for axially positioning said axial compressor and said radial compressor relative to each other; and

means for securing said compressor shaft against axial displacement;

wherein said transition duct favorably directs the output of the axial compressor into said inlet of the radial compressor and said exhaust cone section encloses sufficient volume to moderate the output of said radial compressor.

4. The supercharger as claimed in claim 3, wherein said exhaust cone portion has a half-apex angle of approximately 35°.

5. The supercharger as claimed in claim 3, wherein said transition duct has a half-apex angle of 35°.

6. The supercharger as claimed in claim 3, wherein said transition duct is substantially coaxial with said inlet of the radial compressor.

7. The supercharger as claimed in claim 3, wherein said axial compressor comprises a hub, a plurality of blades extending radially from said hub and a shroud connected to tips of said blades.

* * * * *

Kuns, Ray F. Automotive Essentials. Rev. ed. Milwaukee: Bruce Publishing, 1950. 229-30.

Superchargers. The supercharger is a device which supplies pressure to the feeding of the fuel mixture into the engine cylinders. Instead of making the engine depend upon its natural pumping or "sucking" action to draw the mixture through the carburetor and into the combustion chambers, the supercharger forces the mixture into them under pressure. The "suction" of the engine is added to by pressures ranging from several pounds above normal air pressure to as much as 15 lb.

Under full throttle with a supercharger, the manifold pressures are positive at all engine speeds. Since, with a nonsupercharged engine, a negative pressure (vacuum) ranging from one to several pounds is required to "draw" the mixture into the cylinders, the effect of the supercharger is actually much greater than any gauge pressure reading would indicate. Several pounds of "vacuum" are replaced by several pounds of "pressure."

The limitations placed upon racing motors led to the development of superchargers for automobile motors on the order of those used on airplanes. The supercharger is a necessity for airplane work (when the flights are at unusual heights) because of the fact that the air grows rarer or thinner as the distance from the earth increases. This results in only a partial charge of air and gasoline for the engine, unless the supercharger is used.

In an automobile racing engine, the normal air pressure of 14.7 lb. per square inch may not be sufficient to force air in through a standard carburetor and give a proper charge of fuel. The speed (revolutions per minute of the engine), therefore, depends on some means of getting the air and gasoline mixture into the cylinders at a faster rate and in a more positive manner. Either a supercharger is used or the engine is equipped with multiple carburetors, usually one for each two cylinders.

Several types of superchargers, designed to give pressure fuel-mixture feed to gasoline motors, are shown in Figure 294. The type shown at A is on the centrifugal order; that is, it operates on much the same principle as the water pump on the automobile engine. Tremendous speeds are attained by superchargers of this type. The periphery of the fan is set to travel at about 720 m.p.h. at which speed the pressure available for forcing air and fuel into the cylinders is about 16 lb. per square inch. This, added to the vacuum of the engine, gives a pressure of 20 to 28 lb. per square inch. With this pressure, the valve area is not so important.

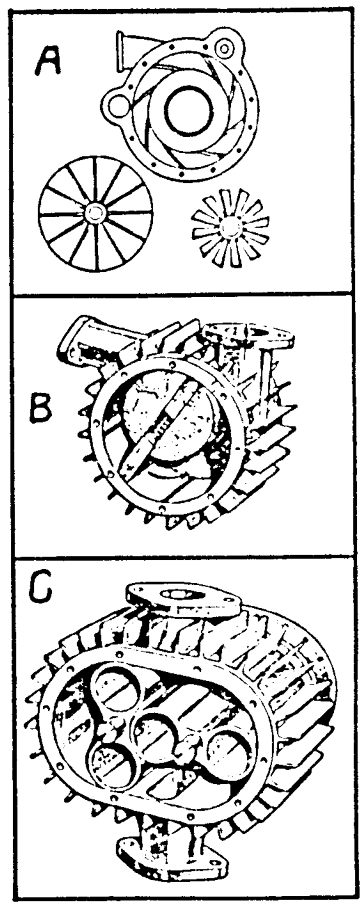
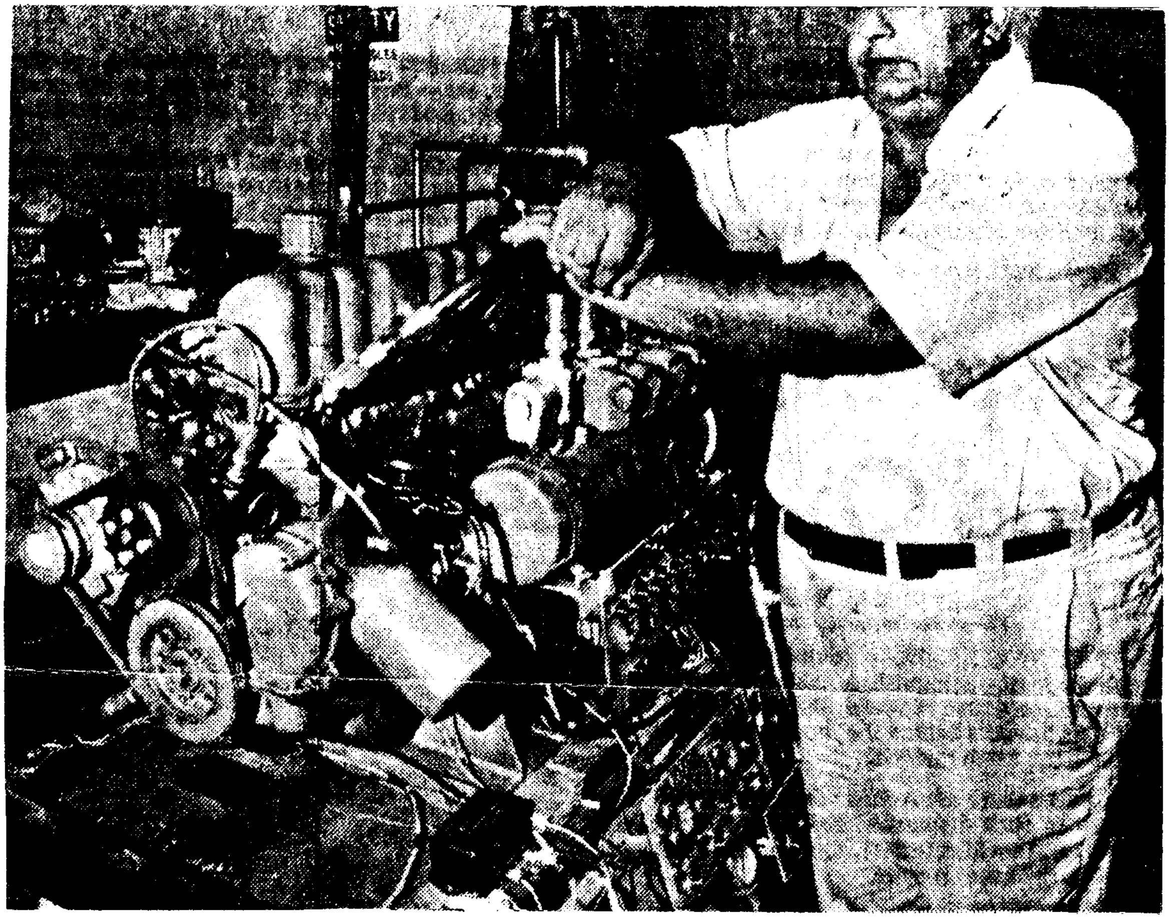


Fig. 294. Supercharger design.

The supercharger shown at B is of the vane type. It works much the same as the vane-type oil pump. The supercharger shown at C is on the order of the Roots air blower. It will be noted that in the vane, as well as the Roots blower, there is an attempt at confining the air thus forcing it ahead of the rotating units of the blowers. These are known as positive displacement types. They operate at about 1.5 times crankshaft speed.



Rich Cordes/Staff Photo

CARL LEISSLER EXPLAINS HIS COMPRESSED AIR ENGINE
Trick Will Be To Make It Regenerate Its Energy

This One For The Road Runs On Compressed Air

By BOB FRENCH
Sun-Tattler Staff 7-14-80

Carl Leissler has a dream: developing an engine that runs efficiently, produces no pollution and uses the free resource of air as fuel.

Although the experts say it is impossible, Leissler, a retired Hollywood horticulturalist, has been working on his idea for 15 years and says he is close to the realization of his goal.

At a western Hollywood garage littered with tools, engine parts, electronic equipment and air compressor tanks, generators, and hoses, the 58-year-old balding inventor proudly shows off a bright blue straight-six cylinder Ford engine he adapted to run on compressed air. He adjusts several switches, checks two air tanks sitting below the engine, sitting on a bench, and switches on an aircompressor standing in the corner of the room.

WHILE THE noisy compressor fills the tanks with compressed air, the amiable Leissler checks several gauges mounted on hoses leading into the cylinder head and adjusts valves on the hoses leading from the tanks. Finally when everthing is ready, he pushes a button starting the unusual engine.

A low hum is heard as compressed air is shot into each cylinder as dictated by a electronic distributor mounted on the side of the engine block. Pistons in each cylinder are driven down by the force of the air and turn the connecting rod, as is evidenced by the spinning flywheel at the end of the block.

"It runs; it works," Leissler beams.

BUT THE inventor wants more than just a machine converting the power of compressed air into mechanical motion. Leissler believes the engine can drive an air compressor to renew its tanks with a fresh supply of compressed air; thus continuing the cycle without having to use an outside energy source, or at the least, requiring only a small amount of electric or gas fuel to keep it running. Currently a smaller air compressor sits at the end of the engine,

which can be driven by belts from the motor, and Leissler is working on removing some "bugs" that have prevented it from operating effeciently.

Leissler, who has registered patents on the process, began building the air compressor driven engine about a year ago. He has formed a corporation, Alairende, with two other partners to fund and promote the project.

Plans are already under way by Leissler to install a Chevy four cylinder engine driven by compressed air into a car sometime this summer. He says the car may use some kind of small electric or gas energy source to help drive the air compressor.

"WE MAY be able to get 2,000 miles per gallon. "Air is a power in itself."

After running an engine on air and using the power to drive outside gears, Leissler says the next step is to make the machine "reciprocating," running on an air compressor attached to it to resupply the engine's compressed air. By mid year he predicts he will have finished ironing the bugs out and will realize his dream.

NOT EVERYONE agrees with the inventor's theory. Dr. Harold Plass, professor of mechanical engineering at the University of Miami, says the idea is impossible. He remarks the idea violates the physical laws of thermodynamics which require energy to be conserved.

Once the energy is used by the motor to drive a car or operate other equipment, it is gone and will have to be replaced by new energy from an outside source, the professor explains.

"You can't have something for nothing."

PLASS SAYS the energy lost will not be made up for by the attached compressor as it will have less energy to operate with too.

"This is not a perpetual motion machine," Leissler insists. "It will lose some air, bearings will go out and there is some friction."

But Leissler has confidence the engine-driven compressor will more than make up the lost air compression available to the engine. "The pump puts out 12 times the amount necessary."

LEISSLER SAYS the idea came to him for running an engine on compressed air 20 years ago when he got one of his fingers caught in a fan belt and used a blast of compressed air in one of the cylinders to turn the crank and free his digit.

"I don't care how much money it'll make.

"I want her," he remarks, putting his 3-year-old daughter, Lianne Marie, on his knee, "to have a better world to live in."

USA TODAY · TUESDAY, JUNE 19, 1984 · 5A

OFFBEAT USA

THE HUMAN SIDE OF THE NEWS

His invention could fuel a new type of car engine

JOHNSTOWN, Pa. — George Miller's invention shouldn't work. An engine that runs efficiently on nothing but air is considered scientifically impossible. But Miller, 58, doesn't know much about science; he dropped out of school after the seventh grade. Not knowing what couldn't be done, he built an engine that not only runs on air, he said, but replenishes its own air supply. Miller, a garage tinkerer and former coal miner, said it took eight years and an investment of nearly $50,000 to convert a 4-cylinder Buick gasoline engine into an air-powered motor. "The federal Department of Energy told me it amounts to a perpetual motion machine," Miller said. "And that's against the laws of science. Well, they'll just have to change the laws." Miller has applied for government and private grants to develop his engine for use in vehicles or to generate electricity. But, on the advice of a patent attorney, his blueprints are sealed in a vault. "Nobody sees them until I've got a signed contract in my hand," Miller said. He's not so concerned about profit from his invention as he is about how it's put to use. "I've seen the wars and killing because of the shortage of fossil fuels," he said. "If this works — and it does — there's no need for that anymore."

The Pittsburgh Press

Sunday, July 22, 1984

#124

Air car

Inventor's patently convinced success depends only on financial backing

By William Allan
The Pittsburgh Press

JOHNSTOWN — George Miller's garage is a mess.

It's dominated by half a car, the front portion with hood removed. Inside sits a four-cylinder engine from which radiates a series of relatively large rubber hoses connected to rusting tanks. All around are tools, gadgets and gizmos.

Focus on the engine. It wheezes, coughs, clatters and pops, but it runs — on air.

"It's running now at about 500 rpm (revolutions per minute) on about 20 pounds (per square inch) of air pressure," says Miller.

He's a fascinating person, thin and graying, with piercing steel-blue eyes and a habit of speaking quickly and then letting the words trail off, as if his brain is working too fast for his tongue.

The engine is his invention. It's a medium-size, 4-cylinder engine out of a 12-year-old Opel. Air from one of the tanks is fed into it through the spark plug holes, and air pressure moves the pistons.

"It would run forever," says Miller. "The air is recirculated out of the engine and back into the tank, but you can see that ..."

Miller envisions the engine as a solution to fuel and pollution problems, and the end to the Middle East wars.

"Why else are those people fighting for that land over there?" he asks. "Nobody would want it except for the oil and gas. Wouldn't you like it if you didn't have to worry about your kids going off ... to ... war?"

The Johnstown inventor has taken his idea to the U.S. Department of Transportation, the National Aeronautics and Space Administration, the Patent Office. He has been visited by state senators, University of Pittsburgh engineers and financial entrepreneurs.

George Miller and his air engine have been written up in national and local newspapers. His story has been dispatched by the wire services, shown on television and mentioned by Johnny Carson.

But while a path at least has been started to the door of the inventor, no one with money has ventured down the dirt lane in Richland Township, high above the Cambria County city made famous by floods and steel mills.

"I've spent over $50,000 and 10 years on it," Miller says. "I started first with a magnet, then a hydraulic engine and now air. I'd go along with anything if I could get someone to stand behind me so I could afford to do what I want."

While the 58-year-old retired coal miner and bricklayer maintains he has "all the answers," he says he needs money to develop the engine. He's applied to the government for grants, spoken to private investment sources and written Honda Motor Co. in Japan.

"They (Honda) never answered," he says. Others have put him off one way or the other. NASA and the federal transportation department discussed the air car with Miller and told him "to come back and talk anytime."

"I think I would have done better with the government if I didn't have all the answers," Miller says of the developmental money. "They give money to develop something, but my engine works."

> *"I think I would have done better with the government if I didn't have all the answers."*
> *— George Miller*

He's accustomed to people laughing at him.

"I told my doctors, and they laughed," says Miller, who has suffered eight heart attacks in a decade. He lives on $465-a-month Social Security disability benefits brought on by the attacks and a bad back.

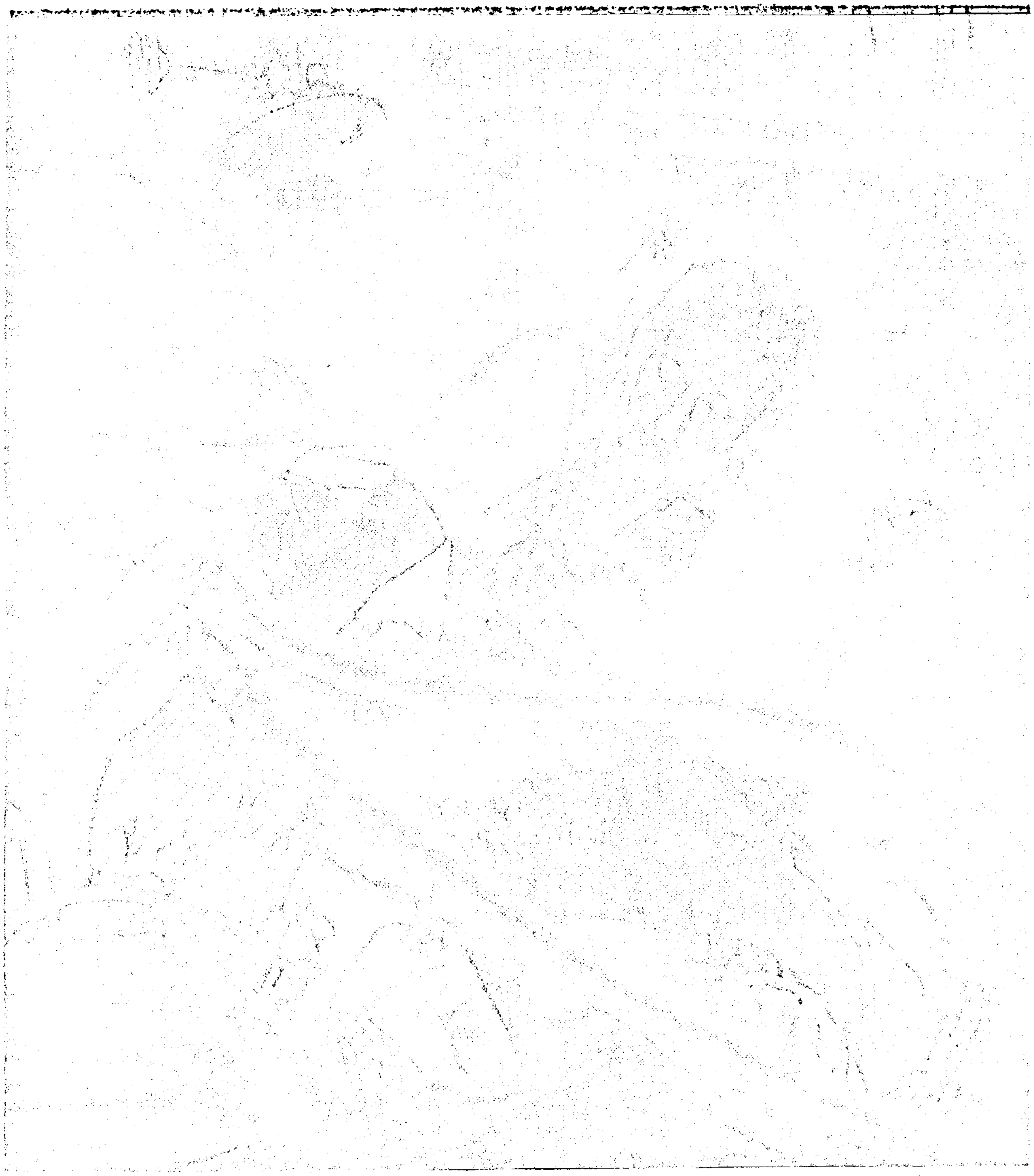
"Engineers say you can't get something for nothing, but I can prove it to them. This thing works, but if I tell them *how* it works, they won't need me."

He's particularly secretive about what he terms "the energizer" but has made a preliminary disclosure to the Patent Office prior to applying for a patent.

Assessing the engine is not easy.

Air engines are not new, exactly. William Truitt of McKees Rocks developed one 10 years ago, and a Harrisburg man applied for a patent on another.

Basically, they all are turned over by a conventional auto battery and then run on the compressed air powering the pistons. The key is to



William Allan/The Pittsburgh Press

George Miller tinkers with engine while he looks for money to get it rolling

keep up the air pressure. [illegible] employs a 60-horsepower gasoline engine to compress the air in his vehicle.

Miller employs the energizer, which he does not show everyone, but which sounds like a turbine.

In addition, most other alternative engines — electric, steam, natural gas, propane — have not been prospering recently because — despite wars, famine and OPEC — oil from the Middle East has been flowing at a rate steady enough to keep the gasoline prices relatively inexpensive.

Barry Denk, director of CENTECH, at the University of Pittsburgh's Johnstown campus, is the person closest to Miller who could help with financing. CENTECH has been set up by the state specifically to help Pennsylvanians with ideas that might lead to new industries.

Denk and a Pitt engineer recently saw the engine in Miller's garage.

"Unfortunately, the air engine was not operating at full capacity, and therefore Mr. Miller could not prove to the engineer what he professed that the engine can do," Denk says.

The Pitt director added that he and the engineer would like to see the engine powering a car.

'We have not made a final judgment as to whether the product has merit," Denk adds. "Mr. Miller professes that his engine will produce more energy than it consumes, and my engineer felt that that was not possible. However, he said in all fairness to Mr. Miller he'd reserve final judgment until he sees the thing in full operation."

Denk said they never saw the energizer in operation.

"It had blown up or something, so Mr. Miller hadn't gotten it working to his own satisfaction," Denk says. "Certainly if it has merit, the air engine is something we want to be involved with. We've been involved in a number of projects that we questioned at first glance but which have become successful and resulted in jobs.

"We are not looking at this thing half-heartedly. We are very serious because we know Mr. Miller is. But at this stage we are not certain it has merit."

Miller admits he has run the air-powered car only "back and forth down the lane."

The Johnstown inventor has a videotape of a car powered by the air engine. It shows the engine running in the car but does not show the vehicle moving until the tape's final scene, in which the car is barely able to limp back into the garage.

Miller argues that an old gasoline engine was not meant to run on air pressure and "leaks quite a bit," that an engine specifically engineered and machined for air would be much more efficient.

Of all the alternative engines developed so far, the natural gas and propane engines have come closest to meeting all the requirements, but still have been limited to a trickle of Detroit's production.

Miller says he has run a lawn mower and motorcycle engine on air and that he also has an alternative use for his invention: generating electric power for his home.

"I'll have the electricity shut off here in no time," he says.

Inventor says he can revolutionize the auto industry with his . . .

Engine that runs on air

Inventor George Miller says his incredible new auto engine will cut costly fuel bills, solve pollution problems and stop wars — it's powered by air.

"It would run forever," said the gray-haired retiree.

His amazing engine once whirled under the hood of a 1972 Opel. It is medium-size and has four cylinders.

A retired coal miner who lives on $465-a-month Social Security disability payments, Miller envisions his air engine as a solution to the Middle East wars, pollution and fuel costs.

"Why else are those people fighting for that land over there?" he asked. "Nobody would want it except for the oil and gas."

Though his miracle engine has caught the eye of the U.S. government, politicians, the press and knowledgeable engineers, no one is breaking down his door.

An agency called CENTECH that helps people with new ideas sent its director, Barry Dent, to Johnstown, Pa., to look at Miller's miracle engine.

"We have not made a final judgment as to whether the product has merit," Dent said.

"Mr. Miller professes his engine will produce more energy than it consumes.

"But my engineer felt that was not possible." However, he said, in all fairness to Mr. Miller he'd reserve final judgment until he sees the thing in full operation.

"We have been involved in a number of projects that we questioned at first glance but which have become successful and resulted in jobs," Dent said.

Miller has applied for government grants, spoken to private investors and written to Honda Motor Co. in Japan. Honda never replied and the others told him "to come back and talk anytime."

"I think I would have done better with the government if I didn't have all the answers," said the mechanical whiz.

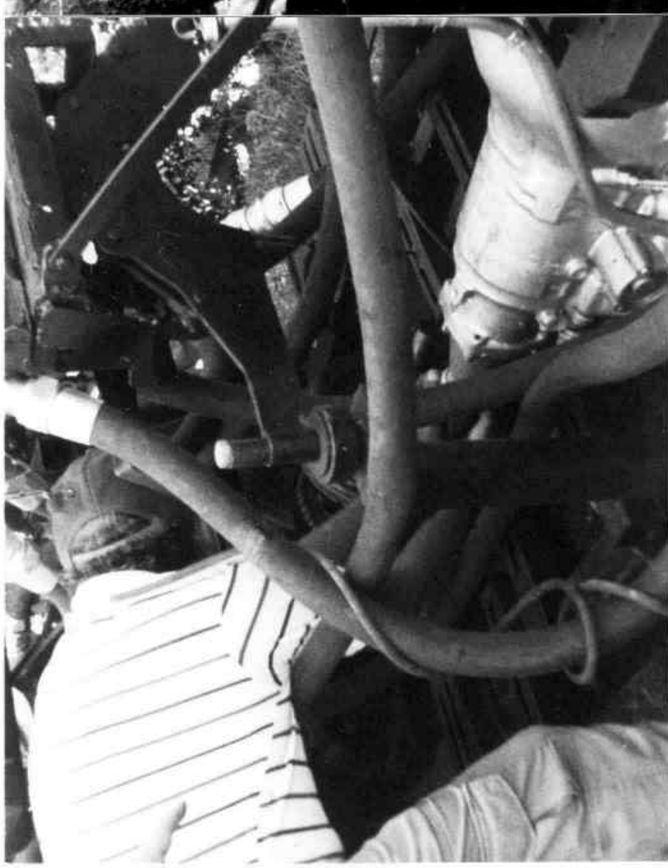
"Engineers say you can't get something for nothing, but I can prove it to them. This thing works, but if I tell them how it works, they won't need me."

INVENTOR George Miller says his engine will run forever.

Ricardo Perez Pomar with his
self-fueling air car and
backer Michael Lavin

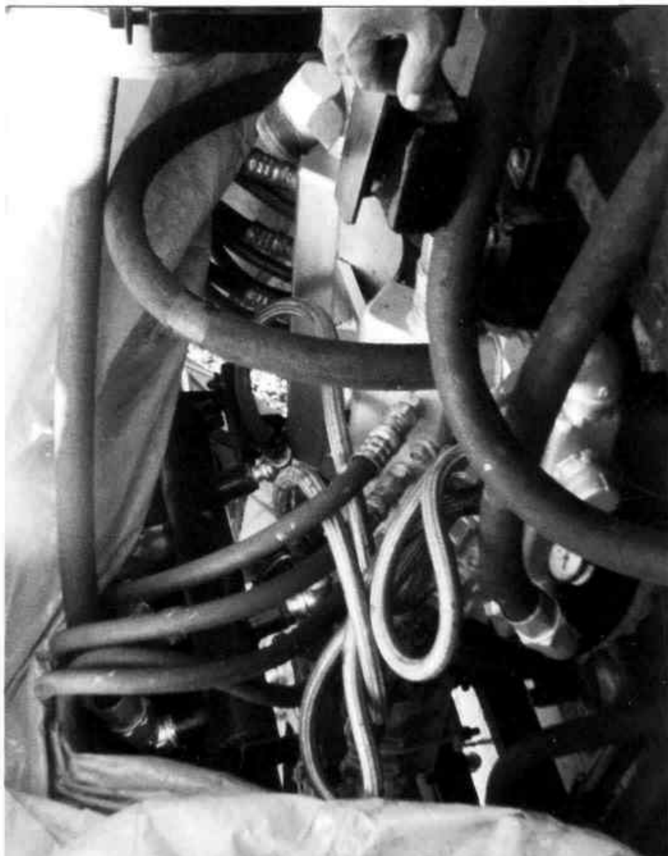
May 1987

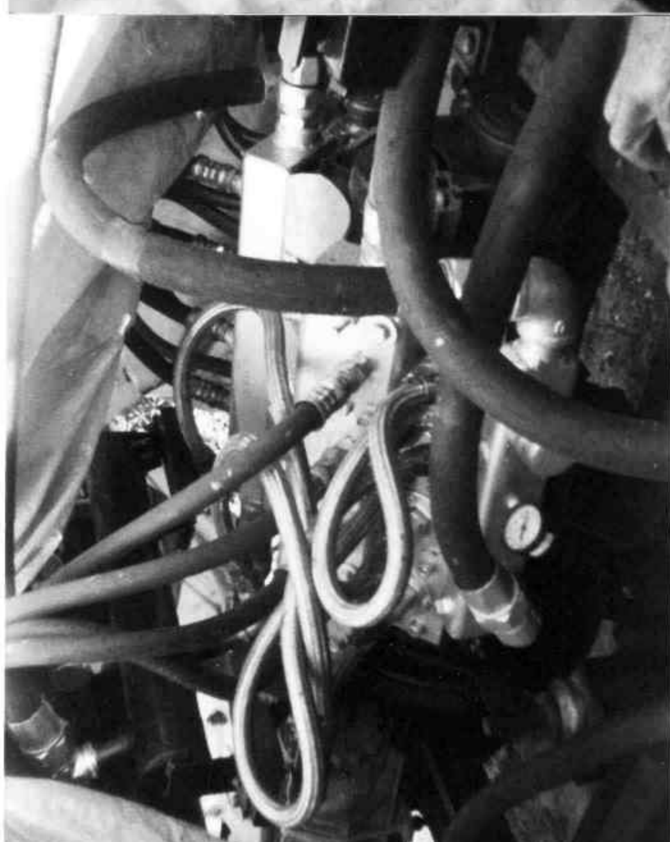
Photos by David London

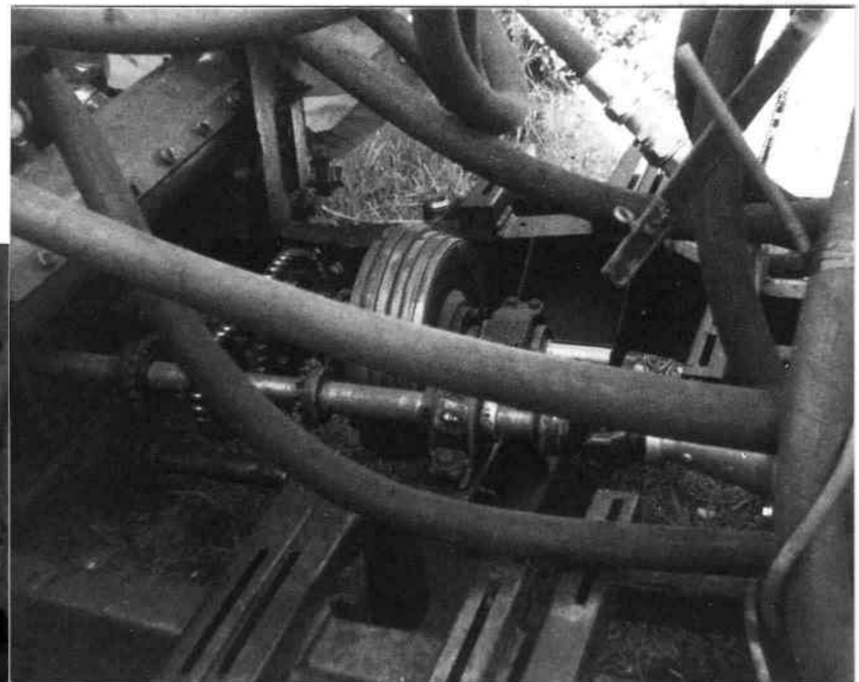


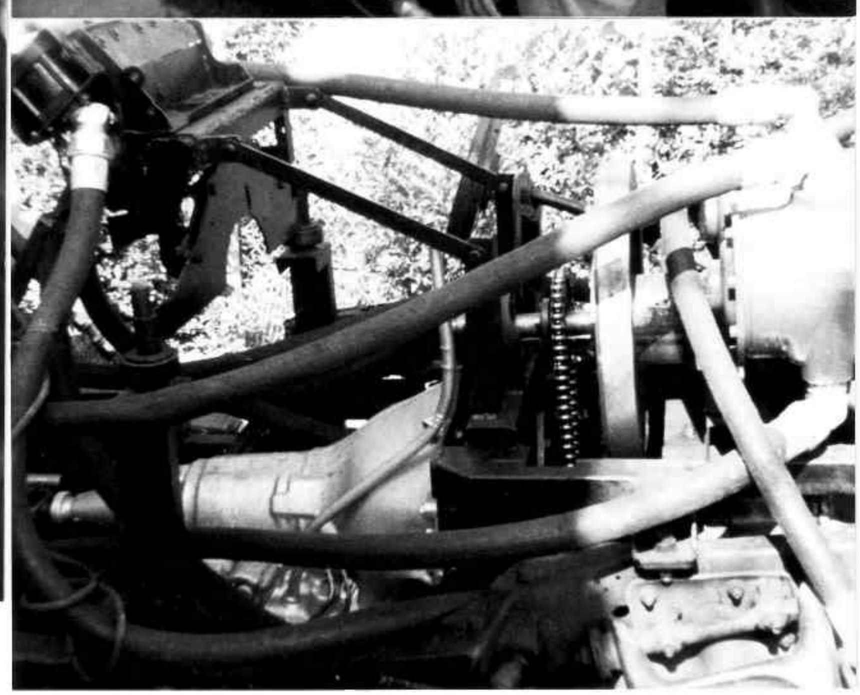
Perez Air Car (continued)

Photos by David London



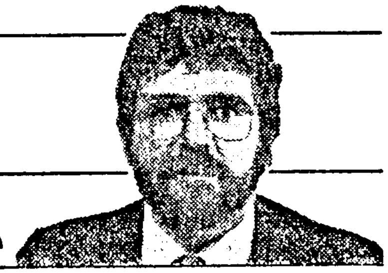






'Perpetual motion' revisited: Two laws are still against it

Steve Doig



Miami Herald

Miami inventor Ricardo Perez Pomar is convinced that he has solved the world's energy crisis. Alas, I'm equally convinced that he's wrong.

Perez, a 61-year-old pneumatic engineer who came here from Cuba in 1978, recently showed me his so-called air cycle machine. In essence, it is an engine driven by compressed air.

Nothing extraordinary there. What demolishes my belief is his claim that the engine will refill continuously the very tank of compressed air that powers it.

"This machine can be in full operation for months and months before its air tank must be artificially refilled," Perez promises. "The days of the energy crisis and of atmospheric contamination are over. . . ."

Uh, oh. Perpetual motion again.

In fact, Perez's concept of using an engine to supply its own power actually is more than three centuries old.

Consider, for instance, the proposal of English physician Robert Fludd, who in 1618 designed a closed-cycle water mill. Fludd's idea was to use falling water to drive a waterwheel, which in turn would drive a pump to lift the water back up above the water wheel — and so on.

Despite the obvious usefulness of Fludd's idea, it took more than 200 years before scientists managed to figure out why no one could build a successful working model.

The reason for the chronic failure was a 19th Century discovery called the First and Second Laws of Thermodynamics.

The first says you can't get more energy out of a system than you put in. The second says that, because of friction and other heat losses, you won't even retrieve the same energy you put in.

In short, you not only can't win, you aren't allowed to break even.

Still, Perez is certain that he can actually come out ahead. He says he can drive a series of compressors with their own compressed air and still find excess energy in the system with which to do useful work.

To his credit, Perez has put money — both his own and others — where his mouth is. At a cost of more than $250,000 and several years of labor, he has completed a prototype of his machine. Bolted to a truck chassis sitting in the side yard of his home, the device is an impressive conglomeration of heavy compressors and air motors connected with a spaghetti-tangle of pneumatic hose.

So does the gadget work? Well, Perez indeed has operated it — for nine minutes, he told me. Perez then turned it off, backer Michael Lavin explained, because that short run convinced Perez that it worked as promised.

I have no reason to doubt Perez's sincerity. And he insists that, because his gadget pulls air in, he hasn't invented a perpetual motion machine.

I agree entirely that it isn't perpetual motion. When Perez decides to give his machine a full-scale test, he'll find that the motion is short of perpetual — way, way short.

Sorry, but that's the law. 5/27/87

SELF*FUELING AIR CARS
PRO & CON

Thanks to Bob for his work in air car research. LR) NOTES BY T.F.E.P. (Anonymous)

EINSTEIN SAID ENERGY IS NEITHER CREATED NOR DESTROYED. THIS SEEMS TO BE IN AGREEMENT WITH THIS ARTICLE BY GIL LAWRENCE. SUCH A COMPRESSED AIR POWER SOURCE OFFERS THE MEANS TO UTILIZE ENERGY THRU MANIPULATION, WITHOUT DISSIPATING OR EXPENDING IT. THE POWER NEEDED TO RECOMPRESS IS MINIMAL BECAUSE SUCH RECOMPRESSION IS NOT FROM ATMOSPHERIC PRESSURE WAY BACK UP TO TANK PRESSURE. IN THE POWER STROKE LITTLE DECOMPRESSION TAKES PLACE COMPARED TO THE AMOUNT OF AIR AND THE PRESSURE OF IT AVAILABLE IN THE TANK. IN OTHER WORDS THE ENERGY REQUIRED TO PERFORM THE POWER STROKE IN ADDITION TO THE AMOUNT OF ENERGY REQUIRED TO RECOMPRESS AFTER THE POWER STROKE IS A VERY SMALL AMOUNT COMPARED TO THE AMOUNT AVAILABLE IN THE SUPPLY TANK. THE PROBLEM THEN BECOMES NOT WHETHER OR NOT THERE IS ENOUGH POWER AVAILABLE. CLEARLY THE ONLY PROBLEM IS IN DEVELOPING THE HARDWARE NECESSARY TO MANIPULATE THE AVAILABLE ENERGY WITHOUT LETTING IT SLIP THRU OUR FINGERS.

AIR CAR ACCESS

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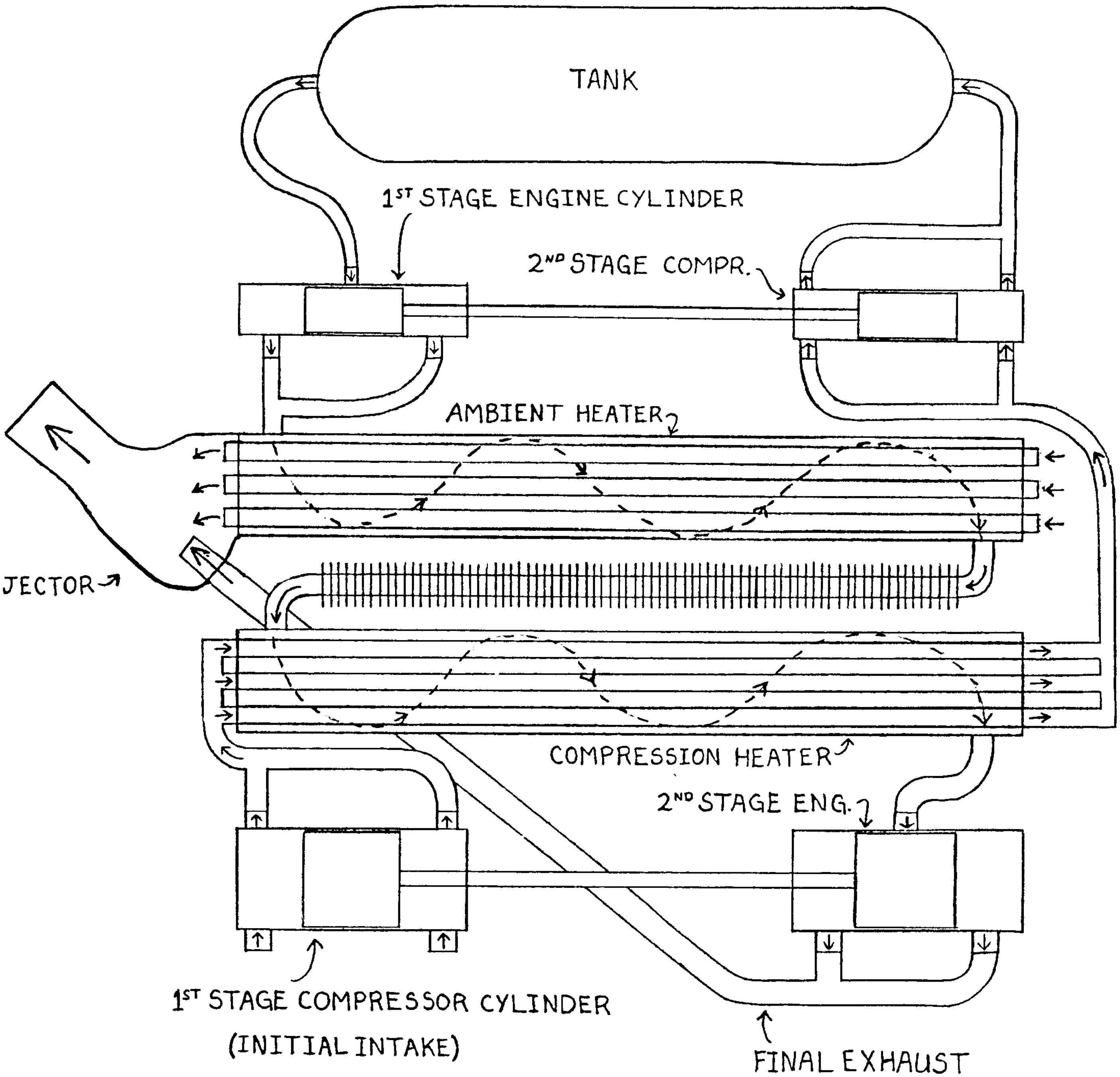


SOLAR AIR ENGINE – MAIN COMPONENTS

TWO-STAGE BENCH TEST MODEL

Solar Air Engine
Two-stage Bench Test Model
Description of Cycle
Luther Rangely - June 6, 1987

Tank starts full from outside source, 300 psi.

Regulator (not shown) reduces pressure of air leaving tank to 250 psi.

Finned pipe absorbs ambient heat to recover energy lost by reduction to 250 psi.

250 psi air enters first stage engine cylinder at ambient temperature, 60*F.

Air expands in cylinder, pushing piston.

Piston pushes second stage compression piston on common shaft.

Partially compressed air already in second stage compression cylinder is compressed further, & pumped into tank.

Meanwhile, expanding air in engine cylinder reaches about -75*F. and exhausts into ambient heater at 50 psi.

-75* engine air circulates among heat exchange tubes in ambient heater.

Ambient air at 60* is being drawn by engine's exhaust through heat exchange tubes of first the compression heater and then the ambient heater.

Engine air is warmed to about 45*, thus expanded 31%, by heat that was already in the ambient air, and is simultaneously heated by compression heat just added to ambient air, to well over 60*; compression heat prevents formation of frost in heat exchange tubes of ambient heater.

Heat exchange tubes in compression heater are surrounded by hot air just compressed by first stage compression cylinder.

Ambient air in compression heater tubes is heated by heat from first stage compression.

Hot compressed air surrounding heat exchange tubes in compression heater is cooled by ambient air, down to ambient temperature, 60*.

Cooled compressed air leaves compression heater and fills second stage compression cylinder on intake stroke.

Hot compressed air leaves ambient heater at 50 psi and enters second stage engine cylinder.

Hot 50 psi air expands and pushes piston.

Piston pushes first stage compression piston on common shaft, compressing ambient air already in compression cylinder.

50 psi air in second stage engine cylinder expands to 2 psi and exhausts to atmosphere through ejector.

Engine exhaust draws ambient air through heat exchange tubes of compression heater & then ambient heater by ejector's jet pump action.

On return stroke, first stage compression piston draws in ambient air.

Engine and compressor based on Tesla concept have no piston rings & no valves except check valves.

Except for check valve parts, entire unit has only two moving parts: the two pairs of pistons on common shafts.

The only friction besides air friction is at the four shaft seals.

The two piston/shaft assemblies don't have to be in exact synch with each other since they aren't linked by any moving parts (no crankshaft, no timing gear, etc.)

In order to not run by itself maintaining a tank pressure of at least 300 psi, this unit must somehow lose an average of at least 31% of the energy being used, during the cycle. A three-stage unit would have to lose at least 55% of the energy being used in the cycle, before the pressure in the tank would go down. The goal is to have the tank pressure rise while the engine runs the compressor.

Possible sources of energy loss to surroundings are: 1) leakage; 2) potential energy in 2 psi exhaust; 3) friction at the four piston shaft seals; 4) air friction; 5) inadequate insulation of any component containing hot air.

Proportions of the four cylinders to each other is critical to get the right pressures. Knowledge of Tesla engine concept is critical to get the correct speed of the two piston/shaft assemblies in relation to each other.

* * *

"We take no stock in flimsy denials based on no better foundation than mental doubt. The operations of computation from the adopted facts and formulas work well within the scope of practical engineering, and it is safe to follow them until something better is found that is based upon an equally good foundation."

Gardner D. Hiscox
Mechanical Engineer
"Compressed Air"
5th Edition, 1909

In thermodynamics, the study of energy and its transformations, a system has an inside (the system) and an outside (the system's surroundings); self-fuelling air car designs will only work as expected if designers structure their work according to the laws of physics. Inside any thermodynamic system there can be only a part of 100% efficiency; the promise of air cars is that they are SURROUNDED by air and heat, that is by their own fuel and fuel medium. A combination of simple one-step processes can convert enough of this surrounding fuel from being outside the system to being inside the system. This is a quiet, non-polluting, safe car whose fuel can never be monopolized.

Understanding Thermodynamics

Energy Conservation—The First Law of Thermodynamics

H.C. Van Ness 1969

Distinguished Research Professor of Chemical Engineering
Rensselaer Polytechnic Institute

Dover Publications, Inc.
New York

Perhaps the ultimate test of our accounting scheme came with the advent of nuclear fission. Energy appears in this case to come from nowhere, but in fact a term provided by Einstein readily maintains the validity of the conservation equation. The new term is a nuclear energy function, and its change is $-c^2\,\Delta m$, where c is the velocity of light and Δm is the change in mass of the system. The minus sign is necessary because Δm is negative; the mass of the system decreases. Our equation then becomes

$$\Delta[U(T,P,\text{etc.})] + mg\,\Delta z + \tfrac{1}{2}m\,\Delta u^2 - c^2\,\Delta m = Q - W$$

Perpetual Motion, the History of an Obsession, Arthur Ord-Hume

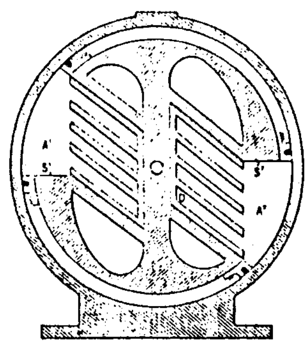


Fig. 93. Compressed air perpetual motion machines range from the patently stupid to deceptively simple yet well-engineered items like this one. Compressed air (or other elastic fluid) is contained in the chambers A1 and A2. Because the surfaces S1 and S2 are larger than the others, the reaction on these is supposed to produce a rotary motion. No air is exhausted but should any escape past the seals, the motor also drives pumps to replenish the air pressure.

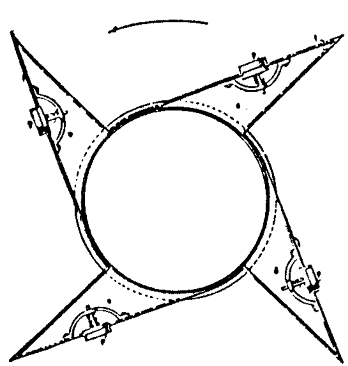
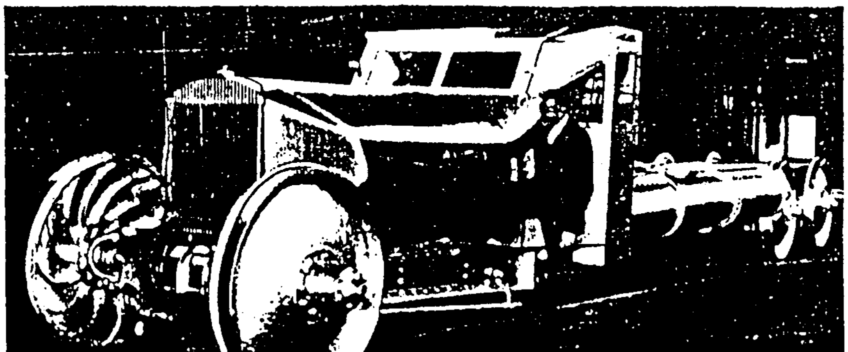
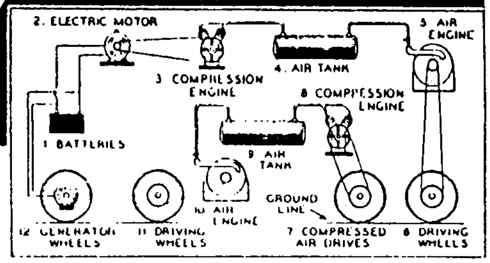


Fig. 94. Dating from 1902, this motor was claimed to depend upon a revised statement of the First and Second Laws of thermodynamics and to consist of a special cycle of working in which the heat rejected in the Carnot cycle was interrupted and made to return to source so making it possible to convert into motive power the diffused heat at ordinary temperatures that exists in the atmosphere or elsewhere. The vessels b, c, d and e are mounted on a shaft a, and have one side f tangential to the shaft, and the other side radial. Compressed air is forced into each vessel through the valves p. It is stated that 'under the action of the internal pressure of the vessels, and after a slight impulse is given to same, in the direction of the arrow, the whole apparatus will begin to move and continue to do so without ever stopping, the velocity corresponding to the pressure established within the vessels'.

The Perpetuity of the Perpetual Motion Inventor





25 ton air electric rail engine ready for tests. Battery drives electric motor running, starting air compressors to get 400 lb. pressure in air tanks; air engine drives car; wheels drive main compressor to refill tanks, and battery charging generator.

FROM coast to coast by rail in 24 hours, traveling literally on air—that is what W. E. Boyette of Atlanta, Georgia, claims for his invention, a railroad engine that runs almost entirely on air.

Air for fuel—speeds of up to 125 miles an hour on rails—low transportation costs—these are possibilities conjured by Boyette's air electric car. After being started by batteries, the car needs only air to keep it running—a close approach to perpetual motion.

Inventor Boyette claims his invention is quite simple, even though it is contrary to all principles of engineering.

Large tanks on the sides of the car are pumped with compressed air by a starting air compressor which is driven by an auxiliary electric motor and 4800 pound storage battery set. Compressed air then operates the air engine connected to the driving wheels, bringing the car up to speed.

As the car moves, a large air compressor directly connected to the front wheels pumps air back into the tanks. An electric generator connected to the farthest rear pair of wheels is continually charging the batteries. Thus the movement of the car refills the air tanks and partly recharges the batteries.

With the engine pulling two passenger coaches over a 250 mile rail run, it is said that about $2.50 worth of electricity for fully charging the batteries at the end of the run will be the only fuel expense.

Air Motor

31346. M~~EANS FOR OBTAINING POWER~~. ANTONIO SOHO, of 59 Humphrey Street, Ballarat, Victoria, Engineer. 16th May, 1912.

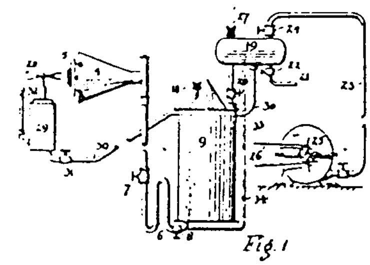
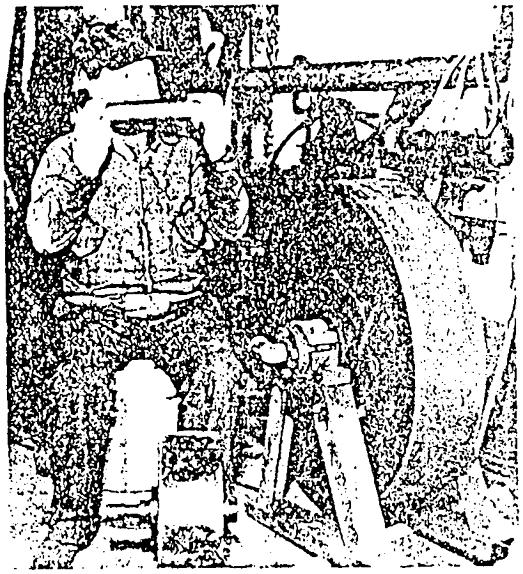


Fig. 1

Relates to means for obtaining power from atmospheric air, and consists of a siphon receiving from a funnel a supply of atmospheric air and which discharges the same into a cylindrical compartment containing a piston adapted to oscillate therein and from which the air flows or is compressed into a storage-chamber (as 19) in which previously an artificial pressure has been set up and which is itself in direct communication with the siphon. Means are also provided for accelerating the air-draught to the funnel, which consists of a fan upon an air-chamber near the funnel, containing air under pressure received from the storage 19, and a nozzle for delivering such air to the fan.

NZ PATENT.

Air Suction Drives Machine



Blowing through a small tube, G. W. Johnston, 60-year-old inventor, demonstrates how air currents and air suction are utilized to move wheels of his new "perpetual motion" machine.

CONSISTING principally of four main wheels, three of which are nearly five feet in diameter and one-foot thick, a novel perpetual motion machine driven by air suction is claimed to have been invented by G. W. Johnston, of Tulsa, Okla.

Valves and other wheels are assembled inside the main wheel, each of which turns on a hollow axle. A turn of the wheel produces an air current at one end of the axle and suction at the other end, serving to keep the machine in motion. A small unit of the device, an eight-pound cylinder, can create eight horsepower under a 100-pound air pressure according to the inventor.

Modern Mechanix

AUGUST.

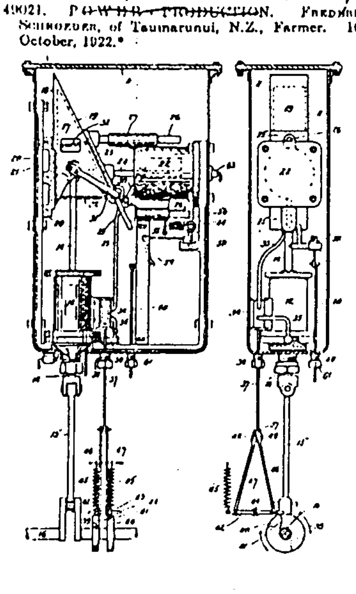
66.3

Air Pressure Engine

49021. P~~OWER PRODUCTION~~. FREDERICK SCHROEDER, of Taumarunui, N.Z., Farmer. 16th October, 1922.*

NZ. PATENT.

4 OCT 1923



This Invention has for its object the construction of a power-producing apparatus or engine that will be self-contained in its operation and continuous in action when certain parts thereof are placed under particular air-pressure conditions. The apparatus or engine designed is dependent for its operation upon the automatic control of variations in the air-pressure conditions to which different parts of the apparatus are subjected, and which variations are caused by the movements of the engine in a cycle such as to alternately and regularly vary the relative air-pressures acting against moving parts of such engine. The invention embodies the well-known principles involved in pneumatics by which air-pressure is distributed evenly over the areas of surfaces exposed to it and acts thereon with power in direct proportion to the degree of pressure, and such power remains the same whether the cubical area be great or small. The invention embodies, as the source of the power-production, a piston moving in a cylinder, one end of which is opened to the zone of air-pressure provided, and the other end of which is closed, so that the said air-pressure is designed to force the piston after it has been drawn in to the open end with a power-stroke outward in the cylinder again, and means combined therewith whereby the resistance to the inward stroke of the piston may be removed in order that it may travel in again under the momentum of a fly-wheel mounted on a crank-shaft driven thereby. The engine is, in effect, a two-cycle engine in which the outward power-stroke of the piston is caused by compressed-air pressure acting on its inside, while approximately vacuum conditions prevail on the outside, and the inward idle stroke is caused by the rotation of the crank-shaft as in an ordinary internal-combustion two-cycle engine. One form of apparatus designed for carrying out the invention is illustrated.

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